University of Southern Queensland

Faculty of Health, Engineering and Sciences

Investigating the Impact of the Request For Information Process in Construction

A dissertation submitted by

Mr Robert Colin Dinsmore

in fulfilment of the requirements of

Courses ENG4111 and 4112 Research Project

towards the degree of

Bachelor of Engineering (Civil)

Submitted: October, 2013

ABSTRACT

The tightening nature of the global economic climate in today's society is putting a significant strain on the efficiency of the construction industry. The impact of additional time and costs as a result of the Request for Information process on construction projects was identified, and the need to reduce said impact was validated.

This document aims to investigate the factors that are associated with the Request For Information process and identify the extent of the impact that this has on the delivery of construction projects from a time and cost perspective.

Parameters were set in order to conduct a case study on a sample set of real construction projects, where relevant data was obtained for analysis. Key project characteristics were revealed that were commonly evident on projects that have had high numbers of RFIs. These projects that are at the highest risk of being impacted by excessive RFIs are Residential/Retirement in nature that have contract values of over $15 million and construction durations of over 11 months.

These projects' RFI registers were then investigated to find that the most frequently questioned design discipline was Architectural.

Having identified these vital pieces of information from the case study, recommendations were made for the implementation of strategies for contracting companies who engage in work that demonstrate said characteristics. These strategies look at reducing the RFI impact on future projects by reducing the number of RFIs that are required and by creating efficiencies in the RFI generation and submission process.

The objectives of this study were met and conclusions were made accordingly as to identify the achievements, limitations and areas of potential future studies.

University of Southern Queensland

Faculty of Health, Engineering and Sciences

ENG4111 & ENG4112 Research Project

Limitations of Use

Associate Prof Kevin McDougall
Head of School (Civil Engineering and Surveying)
Faculty of Health, Engineering and Sciences

CERTIFICATION

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course of institution, except where specifically stated.

Student Name: **Mr Robert Colin Dinsmore**

Student Number: **0050101342**

Signature

Date

ACKNOWLEDGEMENTS

Out of gratitude and respect, I would like to acknowledge those who have helped and aided me through the completion of this research project. If not for these people, my objectives and goals would have been largely unattainable.

Supervisor Mr Paul Tilley has been of significant assistance and guidance throughout the project and I would like to personally make thanks for the knowledge he has passed on to me, and for the preceding studies that he has carried out that I was able to utilise as the backbone to my research.

I would like to thank my employer, McNab Constructions, for the aided inspiration to achieve my project outcomes and for their assistance and support through access to resources and the help of many employees'.

TABLE OF CONTENTS

ABSTRACT .... **I**

CERTIFICATION .... **III**

ACKNOWLEDGEMENTS .... **IV**

TABLE OF CONTENTS .... **V**

LIST OF FIGURES .... **VIII**

LIST OF TABLES .... **X**

LIST OF APPENDICES .... **XI**

CHAPTER 1 – INTRODUCTION **1**

1.1 OUTLINE OF THE STUDY **2**

1.2 INTRODUCTION **2**

1.3 THE PROBLEM **3**

1.4 RESEARCH OBJECTIVES **4**

1.5 OVERVIEW OF DISSERTATION **5**

CHAPTER 2 – LITERATURE REVIEW **6**

2.1 INTRODUCTION **7**

2.2 THE CONSTRUCTION INDUSTRY **8**

2.2.1 GROWTH AND INFLATION 8
2.2.2 TECHNOLOGICAL ERA 9
2.2.3 CONSTRUCTION ORGANISATIONAL STRUCTURES 10

2.3 REQUEST FOR INFORMATION OVERVIEW **16**

2.3.1 THE PROCESS 16
2.3.2 THE RFI FORM 17
2.3.3 CORRECT USE OF THE RFI 20
2.3.4 THE RFI REGISTER 21
2.3.5 INEFFICIENCIES 21

2.4 FACTORS INFLUENCING THE NUMBER OF RFIS **23**

2.4.1 CONTRACT TYPES 24
2.4.2 PROJECT SIZE 28
2.4.3 PROJECT TYPE 31
2.4.4 PROJECT COMPLEXITY (NUMBER OF DRAWINGS) 34
2.4.5 YEAR OF CONSTRUCTION 35

2.5 ROOT CAUSES OF RFIS **36**

2.5.1 DESIGN DEFICIENCY 36
2.5.2 CONSTRUCTABILITY ISSUES 37

2.6 IMPACT OF RFIS - TIME & COST **38**

2.7 FLOW-ON EFFECT OF RFIS **41**

CHAPTER 3 –METHODOLOGY **42**

3.1 OVERVIEW **43**

3.2 PARAMETERS OF SAMPLED PROJECTS **44**

3.2.1 CONTRACT TYPE 44
3.2.2 PROJECT TYPES 45
3.2.3 PROJECT VALUE 45
3.2.4 YEAR OF CONSTRUCTION 45
3.2.5 LOCATION 46
3.2.6 NUMBER OF PROJECTS 47

3.3 DATA COLLECTION **48**

3.3.1 CONTRACT VALUE 49
3.3.2 PROJECT SIZE 50
3.3.3 PROJECT DURATION 52
3.3.4 PROJECT COMPLEXITY (NUMBER OF DRAWINGS) 53
3.3.5 PROJECT TYPE 54
3.3.6 NUMBER OF RFIS 55

3.4 DATA MANIPULATION **57**

3.4.1 CONTRACT VALUE 58
3.4.2 PROJECT SIZE 60
3.4.3 PROJECT DURATION 62
3.4.4 PROJECT COMPLEXITY 64
3.4.5 PROJECT TYPE 66

3.5 KEY PROJECT CHARACTERISTICS **67**

3.6 RFIS CATEGORIZED BY DISCIPLINE **69**

3.6.1 AVERAGED FOR ALL 5 PROJECTS 70
3.6.2 BHC CHURCH STREET 71
3.6.3 REGIS FAIRFIELD MANOR YARONGA 72
3.6.4 VILLAGE AT COORPAROO 73
3.6.5 VILLAGE AT COORPAROO, STAGE 2 74
3.6.6 MASONIC CARE, KIRWAN 75

CHAPTER 4 – RESULTS AND DISCUSSION **76**

4.1 RESULTS **77**

4.1.1 KEY PROJECT CHARACTERISTICS 77
4.1.2 KEY RFI DISCIPLINE 80

4.2 CIRCUMSTANTIAL FACTORS FOR HIGH RFI IMPACT **82**

4.2.1 RELATIONSHIPS 82
4.2.2 PERFORMANCE OF CONSULTANTS 83
4.2.3 CONSTRUCTION DIFFICULTY AND CONTRACTOR EXPERIENCE 83

4.3 RECOMMENDATIONS FOR STRATEGY TO LIMIT IMPACT **84**

CHAPTER 5 – CONCLUSIONS **86**

5.1 ACHIEVEMENTS **87**

5.2 LIMITATIONS **88**

5.3 FURTHER WORK **89**

REFERENCES **90**

APPENDICES **90**

LIST OF FIGURES

Figure 1 - An over-arching look at the RFI process in construction........................... 3
Figure 2 - Construction historical revenue (Korda Mentha 2012).............................. 8
Figure 3 - Construction annual growth (pa, past five years)...................................... 8
Figure 4 - Typical Structure for Construction Organisations 11
Figure 5 - Typical Organisational Chart for the operations of a project.................... 15
Figure 6 - An example of a blank RFI template (Fluor Australia 2013).................... 18
Figure 7– Primary Factors influencing the number of RFIs on a project 23
Figure 8 – Differences between Construct Only and D&C contracts........................ 24
Figure 9 – Dombkin's WHOW matrix - Construct Only v D&C 27
Figure 10 – Project characteristics that gauge the size of a project 28
Figure 11 – Constraints for measuring project size 30
Figure 12 – A photo of a Civil project - 150 Mega Litre Dam 31
Figure 13 –Photos of Commercial projects... 32
Figure 14 –Photos of Education projects 32
Figure 15 –Photos of Government projects 33
Figure 16 –Photos of Industrial projects... 33
Figure 17 –Photos of Residential/Retirement projects 34
Figure 18 – Personnel involved in RFIs.. 38
Figure 19 –Cost Implications throughout Project Life Cycle 40
Figure 20 – Diagrammatic view of the flow-on effects of RFIs 41
Figure 21 – Distribution of project locations around QLD....................................... 46
Figure 22 – Data Collection for Contract Value 49
Figure 23 – Histogram for Contract Value Data... 50
Figure 24 - Data Collection for Project Size... 51
Figure 25 - Histogram for Project Size Data... 51
Figure 26 – Data Collection for Project Duration... 52
Figure 27 – Histogram for Project Duration Data... 52
Figure 28 – Data Collection for Project Complexity 53
Figure 29 – Histogram for Project Complexity Data 54
Figure 30 – Histogram for Project Type Data... 55

Figure 31 – Data Collection for Number of RFIs 56
Figure 32 – Histogram for Number of RFIs Data 56
Figure 33 – Visual trend for Contract Value verses number of RFIs 58
Figure 34 – Visual trend for Project Size verses number of RFIs 60
Figure 35 – Visual trend for Project Duration verses number of RFIs 62
Figure 36 – Visual trend for Project Complexity verses number of RFIs 64
Figure 37 – Analysis of average number of RFIs for project types 66
Figure 38 – Discipline Information averaged for all 5 projects 70
Figure 39 – Discipline Information for BHC Church Street 71
Figure 40 – Discipline Information for Regis Fairfield Manor Yaronga 72
Figure 41 – Discipline Information for Village at Coorparoo 73
Figure 42 – Discipline Information for Village at Coorparoo, stage 2 74
Figure 43 – Discipline Information for Masonic Care, Kirwan 75
Figure 44 – Flow chart for risk of excessive RFI impact on projects 79
Figure 38 – Discipline Information averaged for all 5 projects 81

LIST OF TABLES

Table 1 – Statistics for Contract Value Data....50
Table 2 - Statistics Histogram for Project Size Data....51
Table 3 - Statistics for Project Duration Data....53
Table 4 - Statistics for Project Complexity Data....54
Table 5 - Statistics for Project Type Data....55
Table 6 - Statistics for Number of RFIs Data....56
Table 7 – Lower and Upper Quartile data for Contract Value....59
Table 8 – Lower and Upper Quartile comparison for Contract Value....59
Table 9 – Lower and Upper Quartile data for Project Size....61
Table 10 – Lower and Upper Quartile comparison for Project Size....61
Table 11 – Lower and Upper Quartile data for Project Duration....63
Table 12 – Lower and Upper Quartile comparison for Project Duration....63
Table 13 – Lower and Upper Quartile data for Project Complexity....65
Table 14 – Lower and Upper Quartile comparison for Project Complexity....65
Table 15 – Comparison of Upper Quartile Deviation percentages....67
Table 16 – 5 projects with key characteristics for further analysis....68
Table 17 – Discipline Information averaged for all 5 projects....70
Table 18 – Discipline Information for BHC Church Street....71
Table 19 – Discipline Information for Regis Fairfield Manor Yaronga....72
Table 20 – Discipline Information for Village at Coorparoo....73
Table 21 – Discipline Information for Village at Coorparoo, stage 2....74
Table 22 – Discipline Information for Masonic Care, Kirwan....75
Table 23 – 5 projects with key characteristics for further analysis....78
Table 17 – Discipline Information averaged for all 5 projects....81

LIST OF APPENDICES

APPENDIX A – PROJECT SPECIFICATION **94**

APPENDIX B – RFI EXAMPLE 1 .... **95**

APPENDIX C – RFI EXAMPLE 2 .... **97**

APPENDIX D – RFI EXAMPLE 3 .... **99**

APPENDIX E – RFI REGISTER EXAMPLE **101**

APPENDIX F – SUMMARY OF RAW DATA COLLECTION **102**

APPENDIX G – RFI LATE RESPONSES (MASONIC CARE, KIRWAN) **104**

APPENDIX H – RFI DISCIPLINE RAW DATA **105**

CHAPTER 1 – INTRODUCTION

1.1 Outline of the Study

To investigate the efficiency of a construction project given the impact of additional time and costs' that accrue from dealing with RFIs as a result of design and documentation deficiencies. The need was identified to minimise RFI impact on future projects.

1.2 Introduction

The construction industry as it is in today's society is driven heavily by factors such as safety, quality, money and program, to name just a few of the more critical ones. The quest for companies to find improvements and gain efficiencies across the whole industry is never ending in the heightening realms of society. The implications for construction organisations that fail to deliver adequately on the aforementioned factors are severe.

Due to the nature of the industry having a large dependence on having drawings, specifications and other documents at everyone's fingertips, there is a reliance on the efficient distribution of information between multiple parties involved on any given project. Information can take the form of letters, plans and specifications, correspondence, contracts and contractual notices amongst a vast array of other examples. For the large majority of construction companies, electronic media is relied upon to be the means of distribution for these types of information.

This research topic will focus on one particular form of correspondence that has a number of associated problems for contractors and subcontractors; the *Request For Information* (RFI) or *Technical Query* (TQ). (CEMDC 2013)

Clients, engineers, architects, contractors, subcontractors and construction personnel in general deal with RFIs on a regular basis. An RFI provides a way for contracting companies to clarify and seek additional information from their client or designers, about a project that they are contracted to build. The RFI is intended to be used for clarifications that are technical in nature only, relating to the design documentation or the constructability of the project.

It is a somewhat common occurrence for contractors to incur additional time and cost while managing the entire RFI process. The extent of such delays and costs will be taken into consideration as the root causes of RFIs are revealed in the research project. Techniques will be formulated and recommendations given to combat the negative repercussions of the RFI process in construction – something that should, in essence, not even be needed. Figure 1 below is a diagrammatical overview of the RFI process in construction.

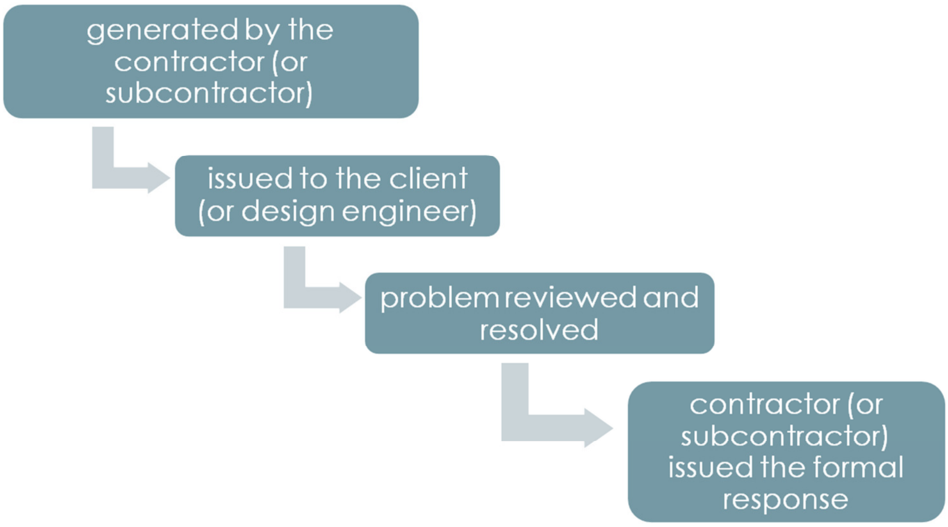


Figure 1 - An over-arching look at the RFI process in construction

1.3 The Problem

In construction, apart from safety and quality, the number one thing on everyone's mind is time and money. Being able to minimise the time it takes to build a job while maximising the jobs profitability is the key to success for today's contractor. The need for contractors to have to question flaws in project design documentation consumes valuable resources. The RFI process would not be required if design documentation was 100% adequate, however it is only inevitable that due to human error and the nature of the construction industry, that there is a need to have an RFI process to clarify such queries.

There are many reasons why there are inefficiency's in the RFI process; some are unavoidable however there are definitely ways to better streamline the process given the sheer volume of time and costs that are wasted. The time and money wasted in the RFI process has been investigated in preceding studies and thus this research project focuses on reducing this impact, by attempting to reduce the number of RFIs needed on a project.

The fundamental aim for this case-study based research topic is to reduce the impact that the RFI process has on construction projects in the future. With the support McNab Constructions Australia Pty Ltd, a number of real projects RFI registers will be utilised to provide data that will reveal trends and statistics for RFIs. The statistics will be particularly applicable to Queensland based mid-tier construction companies who build mainly commercial retail, industrial, residential, and remote energy/mining sector, ranging from project sizes of $500,000 - $30,000,000. The reason why RFIs result in time and cost will be determined and then strategies to mitigate their effects will be formulated.

Reducing the impact is possible by reducing the amount of RFIs that are needed on a job in the first place, and secondly, streamlining the processes involved in creating an RFI itself and how the process is managed.

1.4 Research Objectives

In order to reduce the impact that the RFI process has on construction projects in the future, the two major objectives of this research project are to minimize the number of RFIs needed for future projects and to create efficiencies in the RFI process. The sub-objectives are therefore;

- Using information gathered from construction projects on McNab Constructions' database, identify trends that exist between the numbers of RFIs on a project and key characteristics of the project. Highlight the project characteristics that are attributed to high numbers of RFIs.

- Develop a strategy to streamline the RFI process for projects that demonstrate above key characteristics, this is in order to reduce time and money lost due to the RFI process.

- Strategize and implement efficiencies that will streamline the RFI generation and tracking process.

1.5 Overview of Dissertation

The Literature review is contained in chapter two and it identifies all relevant background information relating to the broader construction industry, the make-up of the organisations involved and what roles they play, and also discusses in depth the parameters around the RFI itself and the process. The factors that influence the number of RFIs on projects are discussed in addition to their related impacts and flow-on effects.

The Methodologies are contained in chapter three and included is a full presentation of the case study. The parameters relating to the sample of real projects are justified and the data collection is presented. Analysis and manipulation of this data reveals key characteristics for projects that impact on large RFI numbers. An investigation into these projects' RFI registers reveals the discipline of design that is questioned the most frequently; this provides the basis of the recommendations and conclusions.

The results of the case study are presented in chapter four, and a look into other circumstantial factors is provided. Recommendations are given as to develop and implement strategies for contractors to look to reduce the impact of RFIs on future construction projects.

The conclusions are made with respect to the initial objectives in chapter five as to provide an insight into whether or not the objectives were met. The limitations are also stated that perhaps inhibited further achievements, while the further studies are also identified to follow on from this dissertation.

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

The ‘Request For Information’ is commonly abbreviated in the construction industry as ‘RFI’ and will be referred to throughout this report accordingly.

The RFI is a standard template form that is issued formally, the details of which are recorded on an RFI register for tracking purposes. Any given project may be subject to anywhere from five to 1000 RFIs, depending on the nature of the project and the client. There are many underlying factors that influence how many RFIs may be required on a construction project and this report will look to identify the major ones.

In the head contract with the client, there will often be a clause that offers an RFI response turnaround time of ‘x’ amount of days, and if the client responds after this amount of time, it is potentially claimable by the contractor as delays. For this reason, contractors will put an onus on tracking the status of each and every RFI to ensure the response is timely.

A contractor would use an RFI if they need technical clarification relating to design documentation (such as drawings or specification), to highlight constructability issues or to propose alternative construction solutions that may differ from the design drawing or specification.

The ensuing chapter provides the theoretical basis for the research project as to understand the construction industry, why there is a problem with RFIs and to appreciate the methodology and thus the results and recommendations.

2.2 The Construction Industry

The construction industry has played a dominant role in the Australian Economy for some time now, and its growth in the past decade has been of notable significance.

2.2.1 Growth and Inflation

"*From an income of around $100,000 million in 2008-09 to an income of nearly $300,000 million in 2011-12*" (Australian Construction Resources 2013), the construction industry continues to grow as a result of public investment in areas such as infrastructure, education and a booming mining industry, that provide the required stimulus. Figure 2 and Figure 3 illustrate the relevant trends that are evident in the construction industry in Australia relating to growth and revenue.

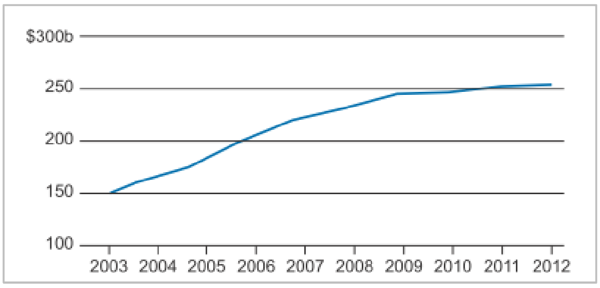


Figure 2 - Construction historical revenue (Korda Mentha 2012)

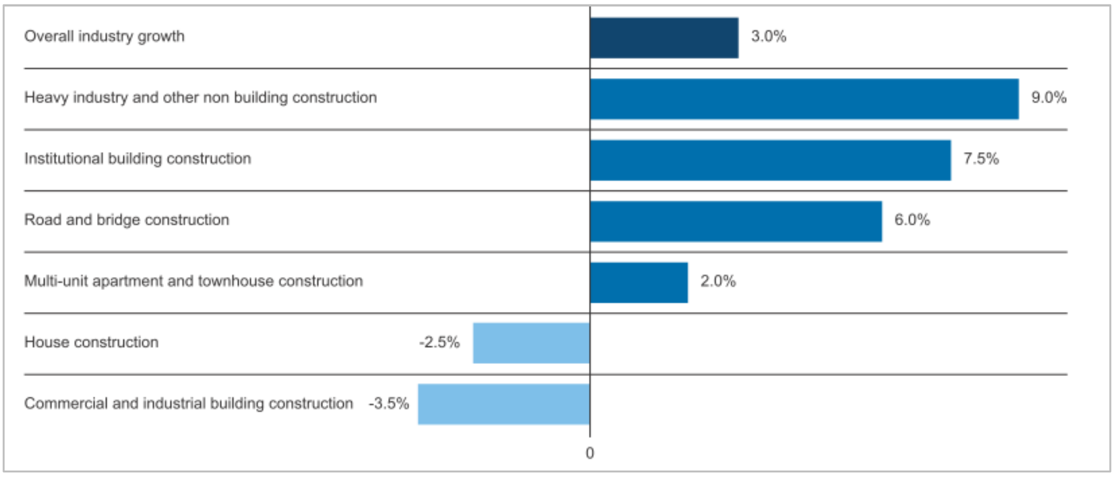


Figure 3 - Construction annual growth (pa, past five years) (Korda Mentha 2012)

This growth is ensuring that employment rates are also steadily climbing, particularly in remote mining sectors, and is predicted to rise in the near future (Australian Construction Resources 2013).

While the total yearly revenue of the construction industry climbs, so does the potential loss of time and cost as a result of RFIs. With revenue growth in construction, naturally comes more projects being built and the value of each project increasing with inflation, and thus there is an increasing importance for effective RFIs that influence the profitability of jobs for contractors. Delays resulting from the RFI process are costly for contractors due to both project preliminary costs (overheads, staff costs, on and off-site facilities, general costs of running the business etc), and on-site delays that disrupt the procurement of materials and the resulting discontinuity of construction. These delays are costing contractors more and more money in the heightening realms of the economy and thus validate a need for this research, in order to reduce the impact that RFIs have on construction projects in the future.

2.2.2 Technological Era

Along with this industry growth, the processes involved in construction to enhance safety, quality and profitability has also had more scrutiny and thus improvement. Technology is relied upon heavily to manage a typical construction project from enhanced computing software, processing power, internet, mobile communications, satellite connectivity for remote locations and advancements in electronic/mechanical construction equipment and machinery. These elements have a significant impact on the development of construction processes both from a management perspective and the running of the project site. The industry is going to continue to see rapid advancements in technology as the Queensland Government have identified that improvements in Information Technology may be the greatest driver of change in the building and construction industry. (Queensland Government 2013)

The main element of technological advancements that is of influence to this research project is computing power and the ease of communication and distribution of files over the internet in recent times. The vast majority of correspondence and communication between construction organisations now occurs electronically, and not just via standard emails. Specific construction management software packages exist that handle the management of all project documentation, from drawings and specifications, to contractual letters and RFIs. No two projects are the same and it is the dynamic ability for technology to adapt to specific requirements which makes it such a great tool for construction organisations to adopt. The increasing size of documents in today's era that are in existence can be processed by technology with ease, even in remote conditions, allowing for the smooth and reliable delivery of documents, drawings and contractually important correspondence. For an organisation to effectively utilise technology that is at their disposal, it takes a great deal of consideration and nous, especially with regards to the interaction that occurs with site-personnel and the elder generation, who may not be familiar and perhaps not willing to accept the change.

When used correctly, (American Institute of Architects 2006) an RFI can provide an orderly, reliable, and documented mechanism to field and resolve legitimate contractor questions and this is something achieved through communication between multiple organisations. The RFI process has been increasingly dependent on electronic delivery and tracking over the past decade and has now reached a point where practically all contractors and clients will process RFIs electronically, along with all other project 'paperwork'. For this reason, this research project will only consider construction projects in recent years with the context that electronic distribution has been utilised. This keeps the study as relevant as possible moving forward as electronic distribution will continue to act as the means for RFI distribution. If pre-technological era case-study information was considered, this would inadvertently incorporate bias into the data. This would be due to the fact that data would incorporate RFI impact stemming from issues that have now become obsolete with the modern use of technology.

2.2.3 Construction Organisational Structures

Differentiating between the organisations and their roles in the construction industry is of importance to this research project, in order to understand how they are involved in the RFI process. The relationships that are made between all organisations involved in any given project are critical to ensure the end result is as-desired and that budgets are met. Figure 4 below shows a typical matrix of relationships between each of the parties involved for traditional style construct-only projects, and in the sub-sections below an explanation of each of their roles.

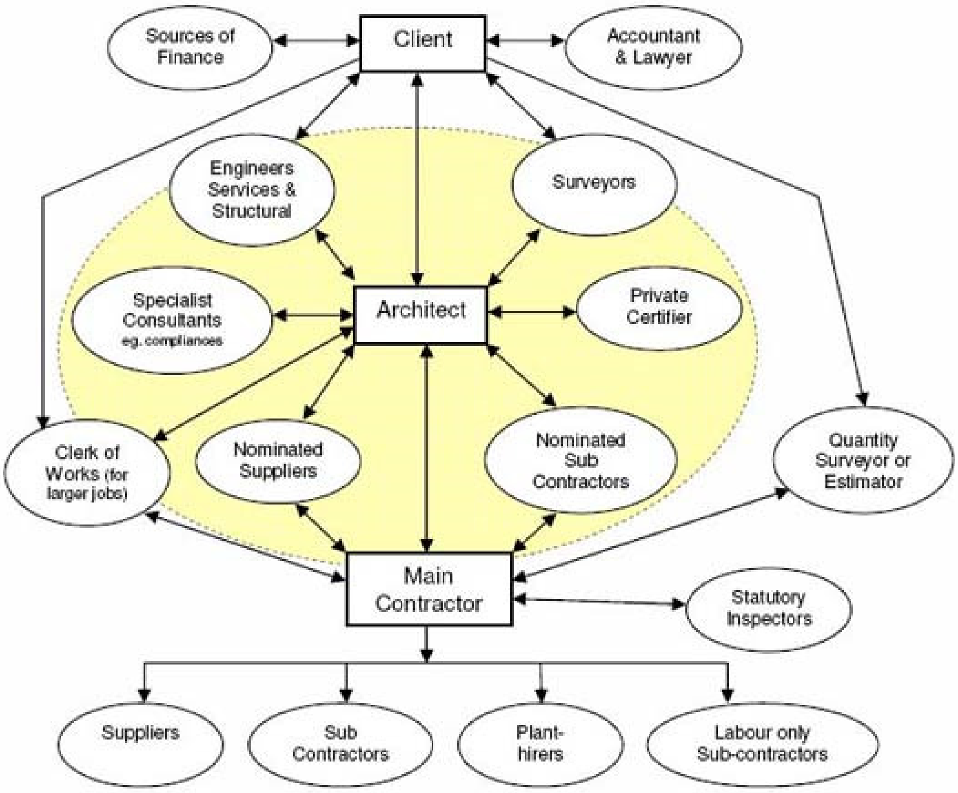


Figure 4 - Typical Structure for the organisations involved in Construction Projects (Dion Seminara Architecture 2011)

There are obviously many other variations of this structure that are successful, and as such this diagram is to be used for a rough visual guide only.

The three major players are the Client (end user), the Main Contractor (builder) and the Clients Representative (acts as a mediator between the client and the contractor, usually the Architect). The relationship and the way that these three parties are engaged with each other, has the largest impact on the way that the project functions. Clawson Architects' LLC (2011) describe this relationship as a "3-legged stool where they must work together in concert".

i) The Client

The Client (in the contractual sense of the word) is the company who pays for the construction project, whether it be a residential or commercial high-rise development, a road, bridge or stadium, an office complex, shopping centre or a gas processing compressor station. Their budget will facilitate and align with their specific goals and expectations of the final product.

The client may or may not be the end-user of the project depending on a number of circumstances. For example to consider a gas-mining company needing compressor infrastructure built, it is typical that these mining companies approach large Engineering Design/Procurement/Management firms to coordinate the whole process from engineering design to finalising construction. Local contractors are then contracted to the Engineering/Management firm as the client, through a head contract, however the end user is the gas company who will be extracting the goods using said infrastructure. This is an example of a client not being the end user of the construction project. As the client in this instance is suitably capable of responding to RFIs having engineering responsibility and capability, the RFI process is dealt with between the contractor and the client, not the contractor and the end user.

An example of a client being the end user of the construction project would be when Woolworths want a new store built. They know what they want but not how to build it. They may have an internal department devoted to the development of new stores to manage the building process from tender stage to construction. It is common for companies of this nature to engage the help of a *superintendent*, to manage the construction of the project and correspond directly with the contracting company. In this instance, Woolworths are both the end user of the build, and the client (albeit with the help of a Superintendent).

The client can engage the full team of consultants to have their project designed, or alternatively liaise with just the Architect who then coordinates the full design. It is the Architect who will most likely be the Superintendent as their objectives align with the client to oversee the contractor, mediating as required. (Fewings 2005)

ii) Superintendent (or Architect)

As stated above, the Superintendent acts as a mediator between the client and the contracting construction company, for most contractual, technical and on-site matters. Their role is to manage the clients requirements in the form of providing accurate detailed design drawings for the Contractor to work to, provide guidance for the client through reasonable and sustainable design solutions, and provide a level of service that ensures a smooth construction process. For clients who are not construction/engineering companies, it is necessary to engage a Superintendent, who for a sum of money, will ensure the project runs smoothly for the client by enforcing the contractor to meet contractual clauses, program and to build as per the design documentation and minimum industry and Australian Standards. The

Superintendent will respond to RFIs and deal with them accordingly to meet the needs of the client and adhere to applicable codes and standards. It is common for the Superintendent to also be the Architect, and figure 4 is formulated as per this arrangement. (McMullan Bros 2013)

a) Consultants

Consultants are the organisations who are qualified to design a job from the ground up and take on liability and risk for the performance of the building and compliance to any governing codes or standards that are applicable. Any given construction project may require input from Architects, Engineers (Geotechnical, Civil, Structural, Hydraulic, Chemical, Electrical, Mechanical etc) Surveyors, Quantity Surveyors, Project Managers, Planners and Certifiers in order for the project to be deemed suitable to proceed with construction.

The consultants can be appointed by the client, superintendent or the contractor depending on the nature of the contract that is in place between said organisations. Consultants will respond to RFIs that relate to their own design and documentation if appropriate.

b) Nominated Suppliers/Subcontractors

In certain circumstances the Contractor must adopt nominated suppliers or subcontractors that are specified at tender time by the client. This may be due to a level of expertise that is required or for relationship/commercial purposes. An example of a nominated supplier/subcontractor may be 'ABC Lifts Pty Ltd' who are engaged each and every time by a particular client for commercial reasons. Nominated suppliers/subcontractors are not considered for the purposes of this report to any further degree.

iii) Contractor

The contractor is the builder who is engaged to the client under the head contract. They must adhere to all design documentation as enforced by the Superintendent, and raise any RFIs accordingly where this is not possible. The typical contractor will manage the construction phase with an organisational structure consisting of the below few key operational roles for any given project:

- **Project Manager (PM)** – Over-arching role (can be a hybrid between office and site-based) with the most influence on any given project. Deals directly with client for all matters. Ultimately responsible for the delivery of the project and accountable for program, turnover and cash flow, quality of construction and overall results. The project manager is concerned with project objectives though the use of human and material resources, within the context of the project environment. (Emmitt and Gorse 2013)

- **Contracts Administrator (CA)** – Working under PM, office-based role fundamentally for processing of all payments and most likely involved in logistics, tendering and letting sub-contracts and contractual notices and letters etc. CA's have a large influence on the day-to-day running of the job and should allow the PM to remain over-arching without needing to get into the minor details or processing/paperwork in the job.

- **Foreman** – On site supervisor responsible for meeting program and adhering to construction methods. Ultimately responsible for everything on site.

- **Safety and Quality Officers** – Responsible for all matters relating to health, safety and Quality Control on site, reports to the Foreman.

- **Site Clerk** – For site based administration, reports to the Foreman.

(Fewings 2005)

Figure 5 below shows diagrammatically the structure as outlined above.

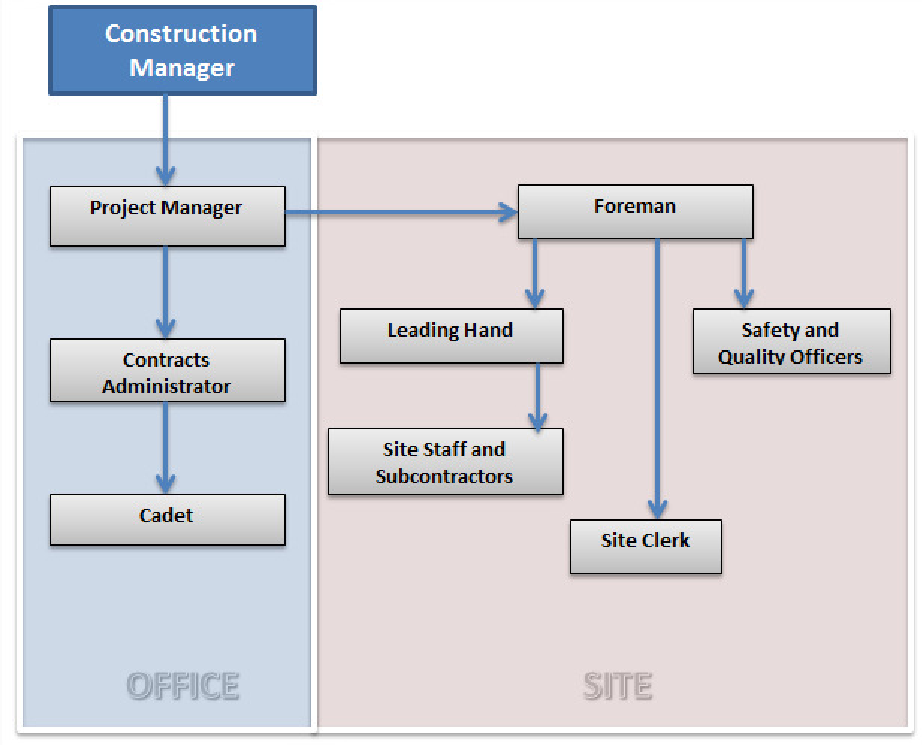


Figure 5 - Typical Organisational Chart for the operations of a project

The contractor will identify the need to submit an RFI, draft it up and submit/track it in order to get a timely response.

a) Subcontractors and Suppliers

A series of Subcontractors and Suppliers will work directly for the main contractor for the construction of the majority of different trades that make up a project. They have a high level of expertise in their specific trade enabling the build to be achieved with greater efficiency. Subcontractors can be contracted in a variety of forms depending on the nature of the project and/or trade. Suppliers are essentially subcontractors without the presence on-site. They will be appointed for items that can be installed by the contractor themselves (for items that do not require the expertise of a subcontractor) or for items that come fully manufactured and require placement only. As subcontractors are more heavily involved in reviewing the drawings that are of interest to their trade, they will often detect the need to submit an RFI. As a contractor, having strong relationships with subcontractors can assist in having open flowing communication with more of a chance to pick up the need for an RFI early on, and have them resolved before they result in project delays, wasted money, lost cash flow opportunities and possibly liquidated damages.

2.3 Request for Information Overview

Implementation of an effective RFI process is an integral part of successful project management for construction projects that improves communication between the construction, design, and project management teams. (Hanna, Tadt and Whited 2012)

2.3.1 The Process

The RFI is a standard template form that is issued formally, the details of which are recorded on an RFI register for tracking purposes. Any given project may be subject to anywhere from five RFIs to 1000, depending on the nature of the aforementioned factors in section 2.2. Creating and tracking RFIs is a process, which Halpin and Riggs (1992) define as "being composed of inter-related tasks where a task may be defined as the basic element of a workflow process which requires time to perform".

Small jobs that are very well designed might not need many RFIs at all, because the documentation is adequate for all details to be constructed by the contractor. This is an ideal situation for a contractor to be in when considering lost time and money as a result of the RFI process. The alternative is for contractors to have large and complex jobs that are not very well designed, that go on for years. These projects are likely to attract a huge amount of RFIs and are obviously attributed with wasted time, resources and money.

In a head contract, it is often stipulated that the client or consultant has a certain amount of time to respond to a contractors RFI and hence the importance of an RFI tracking register comes into play. This is the way that contractors track when each RFI was lodged and when they are expected to be returned with a response. For large projects that may have over 50 RFIs waiting for a response at any one time, the consequences are easy to imagine when contractors do not track the pending RFIs properly. All of these pending design interpretations disrupt the continuity of works and create additional delays and costs.

A contractor would use an RFI if they need technical clarification relating to design documentation, drawings or specification, refer to Appendix B for an example of an RFI where this is the case. An RFI is also able to be used for highlighting constructability issues that are not able to be foreseen when the consultants are designing the project prior to construction, refer to Appendix C for an example of an RFI where this is the case. Another reason to use an RFI would be to propose alternative construction solutions that may differ from the design and specification, refer to Appendix D for an example of an RFI where this is the case. "Contractors can use RFIs in lieu of phone conversations or shop-drawing submission questions, which could be far more efficient in resolving minor issues" (American Institute of Architects 2006).

An RFI is a technical document; therefore the language used is to be concise and technical jargon is recommended, referencing plans and specification, using sketches, mark-ups and data sheets to outline the issue at hand and propose solutions.

2.3.2 The RFI Form

An RFI can come in many different formats and each company typically have their own standard form or template that is utilised. The elements of all contractors RFI forms are fundamentally the same, which give basic prompts for the creator of the RFI to outline the issue at hand and request a desired response time.

Figure 6 below is an example of an RFI form that contains the underlying nature of what is included in a typical RFI, and described also in the below sub-sections is where/how to compose the information. This RFI is an example of a specific form that was generated for the works that Fluor Australia Pty Ltd is contracted to for their client Santos Limited. All contractors that are engaged under Fluor for this project must adopt this template when issuing RFIs. This strategy that Fluor has implemented creates an efficiency on their end in terms of having consistency in the documentation across all RFIs for ease of processing for their document controllers and their team of engineers.

FLUOR

Santos

Santos Limited
Gladstone LNG Upstream Project
Fluor Australia Pty Ltd

RFP/Contract No.: G2NG-KXXX
Appendix B15
Request for Information(RFI)

To:	Contractor:
Cc:	Contract No.:
CWP :	RFI No:
Location :	Sub-System Number :
Reference Documents:	
ISSUE DESCRIPTION AND REASON FOR RFI:	
CONTRACTOR'S INTERPRETATION AND PROPOSED RESOLUTION:	
Originator (Sign) & (Print Name) Title Date	Received Title Date
RESPONSE	
Contract Site Instruction (CSI) Number (if Applicable):	CSI# ☐ Not Applicable
Responders Signature & Name	Date returned to Contractor:

Figure 6 - An example of a blank RFI template (Fluor Australia 2013)

This Fluor form is quite thorough which is advantageous to yield the best results out of the RFI.

i) Administrative Details

The uppermost section is provided to enter the administrative details of the contract and the RFI information for tracking purposes. As Fluor are such a large Engineering/Procurement/Construction company, these details are needed for distinguishing the exact context of the RFI in terms of which project it is for and the discipline of the RFI so the correct engineering department can respond. These fields typically do not exist for most clients in the general construction industry as they are simply not required. The section to enter the RFI number is required on all RFI forms and this allows the RFI to be easily referred to contractually if required in the future. If the response is not adequate or perhaps creates the need for another RFI relating to the same topic, a second RFI can be submitted under the same number, as ‘Revision 1’. This helps to keep the RFI register as clean as possible with each RFI relating to a separate issue.

ii) Referenced Material

There is an area usually provided to reference attached documentation that may strengthen the RFI and this is critical to take advantage of. RFIs are a technical engineering document and therefore referencing attached drawings or specification is an easy way to save long-winded explanations as the construction industry is very visual in nature. The intent of an RFI can be lost if it is explained in lengthy sentences and therefore calculations and/or sketches that are marked up on the drawings help to visualise a problem rather than explaining it. Other referenced material could consist of Material Data Sheets/Product Information, manufacture/supplier/subcontractor recommendations in the form of written letters, calculations, sketches and mark-ups.

iii) Issue/Reason for RFI

This section is to describe the issue behind why the RFI is being raised. The issue must be technical in nature and outlined by the contractor using professional, concise and suitable engineering language. This section should be as concise as possible without sacrificing important details that will influence the intended response. The referenced material should be given context in this section by referring to the attachments as required to ensure they are read in the desired manner.

It is important that the CA or PM discusses the RFI with their foreman prior to submitting it to the client, to ensure the crux of the issue is being addressed as required to proceed on site. As with all contractual correspondence, RFIs should also be proof read by an arbitrary person to confirm it is written correctly and conveying the desired message, free from error (CEMDC 2013).

iv) Proposed Resolution

A proposed resolution that the contractor recommends can be suggested on an RFI and this is intended to encourage the client/consultant to proceed with this method. Often this proposed resolution will be a more cost-effective or timely solution that is of benefit to the contractor, thus achieving this response is ideal. Justification is therefore very important in order to sway the consultants' decision. Not all RFI forms have a designated area where the contractor can propose a desired resolution; however this is an extremely effective tool that should be utilised regardless of whether or not the RFI form has a section for it. A simple example of a situation where this section is useful is outlined below.

Consider if the Architectural drawings do not show the inclusion of bollards in front of a shopfront window adjacent to a car park, and the Structural drawings for bollard details are also omitted, this requires the submission of an RFI as it is the contractors responsibility to know that this is an error in the drawings and that bollards are actually required in these circumstances. This is a perfect opportunity for the contractor to nominate a type of bollard that is of their desire, one that is readily available to avoid lead time and one that is quick and easy to install. Without providing this as a solution, the consultant may respond and stipulate a specific bollard that may or may not be able to be sourced locally and may be more difficult to install.

v) Response

The response from the client/consultant may or may not be written on the original form. Once the response is received, the date should be entered onto the register and it can be seen if the response was received on time or not and hence the need to formulate a delay variation is determined.

vi) Administrative Close-Out

The bottom section on this form has provision for notifications of Site Instructions. As a result of RFI responses that directs the contractor to proceed with a method of construction, a Site Instruction is often necessary in order for contractors to proceed with something that was most likely not originally included in their scope of works in the contract, and thus, will come at an additional expense. It is for this reason that a high number of RFIs on a job will often result in additional Site Instructions and therefore Variations. This is discussed in further detail in section 2.7 (CEMDC 2013).

2.3.3 Correct Use of the RFI

The ideal method to formulate an RFI does differ depending on the particular circumstances and further case-study investigations will recommend the most effective technique that result in full and accurate responses.

In general however there are a number of ways to effectively utilise the sections provided in the RFI form. A possible procedure that contractors can adopt would be for all RFIs to be reviewed and signed off on by experienced or managerial company personnel to prevent RFIs being submitted by someone in a junior position who may not have the required experience to draft it as best as possible (American Institute of Architects 2006). Preliminary research on real case-study data (samples of RFI logs) indicates a vast array of different techniques used to draft RFIs. It is also a good idea, prior to submitting the RFI, to ring the client/superintendent and advise them that an RFI is about to be issued and verbally explain the context behind the RFI. This is a good opportunity to advise the potential impact or severity of the issue at hand and aid in receiving a timely response if an urgent response is actually critical to the project. This also gives the project manager a chance to ensure the RFI is not misinterpreted, by explaining verbally the issue.

2.3.4 The RFI Register

The RFI register is typically an excel based document which lists the RFIs sequentially and is used to track the submission/received dates for all RFIs and enables each of the RFIs to be given a ‘status’ as to whether or not the issue was resolved, not resolved, pending or overdue. This is a good tool to print off and take to client meetings especially if there are a number of pending decisions that may or may not be overdue. An example of an RFI Register has been snapshotted and included in Appendix E. This is for illustration purposes only and is the standard template that McNab Constructions has adopted. This snapshot is the first tab of the excel workbook, which is auto-filled with references to tabs 1-100 which are the actual RFIs. Each tab between one and 100 is converted to PDF and forms the RFI that is submitted.

2.3.5 Inefficiencies

While it is hard to actually quantify the inefficiencies in the RFI process, they can be identified and they tie in closely with the incorrect use of the RFI form as outlined in the sub-sections above. Other inefficiencies may include the time lag between when the issue is first detected on site to when the RFI is actually submitted, this comes down to having adequate resources allocated to the administration and management of the project from the contractors perspective. It is vital to submit the RFI as soon as possible to limit its impact at a later date if a response has not been received yet. Another inefficiency is communication between the subcontractor and the key project personnel (foreman, PM or CA), as it is the subcontractors who detect the large majority of the issues that end up being raised in an RFI. Subcontractors may or may not document the issue and submit in an RFI, and ideally, they should be submitting RFIs themselves however this is not practiced thoroughly in reality. The

RFI template that the contractors use should be issued to all subcontractors and tied into their subcontract from the start, they should draft the RFI and issue to the main contractor in this template as this saves the contractor double handling the information and re-formatting it.

The majority of inefficiencies however stem from the general misuse of the RFI form and lack of understanding of how the RFI form should be best utilised to yield timely and desired responses.

2.4 Factors Influencing the Number of RFIs

The RFI process can vary vastly depending on the nature of the particular job. Projects can differ from each other in a number of ways including various contract types, the project size and its classification of construction sector. The number of RFIs that a project incurs can come down simply to individual personalities of the personnel involved in the project however for the purpose of this dissertation, it is more important to consider the data in terms quantifiable and identifiable factors, as outlined in this section. It is also important to consider how different combinations of these factors influence the total number of RFIs that are raised on a project and this case study will look to reveal the high risk combinations of factors. Figure 7 below represents graphically the factors relating to RFIs.

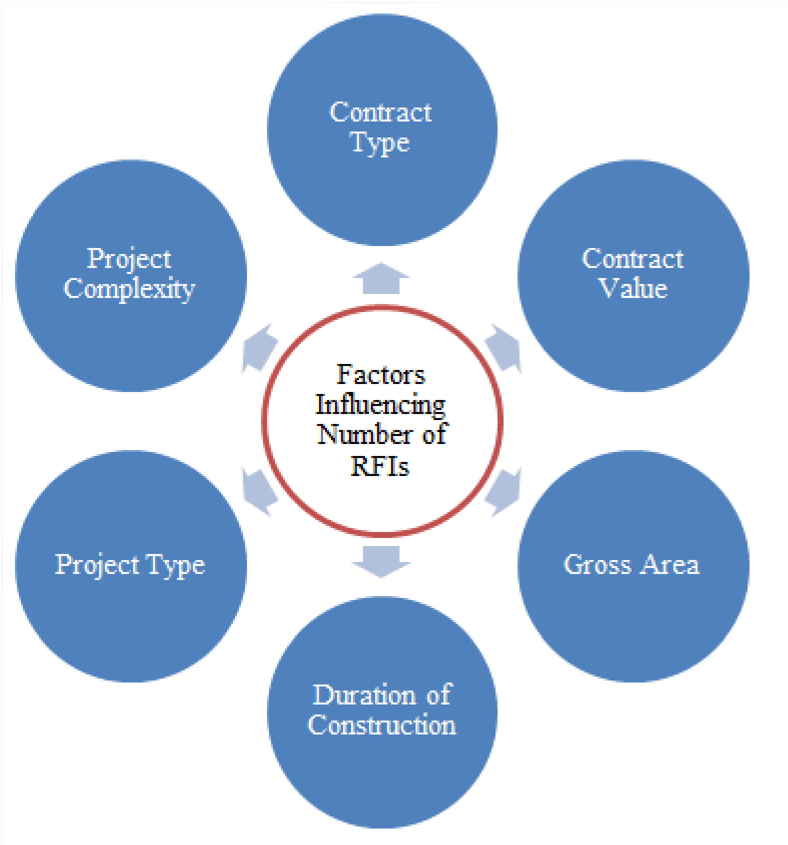


Figure 7– Primary Factors influencing the number of RFIs on a project

It is obvious to say that a small project, of low contract value with minimal complexity will have fewer RFIs needed when compared to a multi-story high-rise in a CBD that will take 2 years to construct. Design and construct contracts will typically attract fewer client RFIs than a construct only contract, and the classification of construction sector will play a part, for example a civil earthworks job would normally attract fewer RFIs than a commercial job with 25 different trades. In making these obvious statements, the background of each factor is outlined below to further substantiate the studies. The most influential aspect that can affect the number of RFIs on a job is simply how well the consultants design the job and communicates through effective and accurate drawings and specifications. This factor is somewhat out of the contractor's power to influence apart from doing due-diligence in selecting the consulting team if it is a D&C job.

The factors outlined below are just a few of the major characteristics that influence RFI numbers on a given project. There are many other minor factors that were not investigated in this study that could all possibly influence RFI numbers, such as geographic location of the job, number of members on the project team or construction personnel manpower. For the purposes of this study these minor factors are not considered further, as it is assumed that the trends would be stronger just considering the below major factors as outlined in the sub sections below.

2.4.1 Contract Types

A contract is an agreement between two parties to do certain things for a legal consideration and this is an agreement, which is enforceable by law (Singh 2009). It is important to distinguish between the types of construction contracts that are predominant in today's industry, and how their varying properties affect the nature of the RFIs. Figure 8 below represents the two predominant types of contracts in the construction industry and outlines a few of their key differences that relate to the issuing of RFIs respectively.

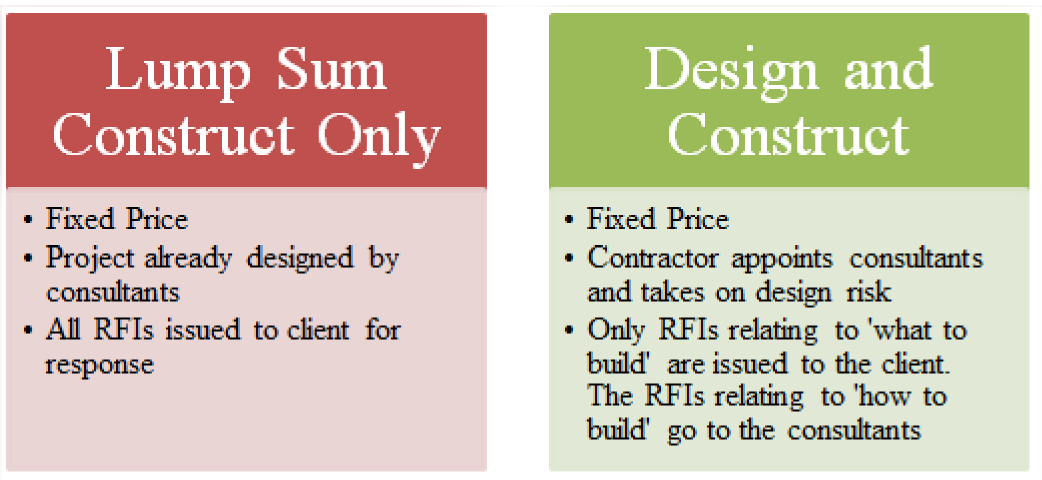


Figure 8 – Some key differences between Construct Only and D&C contract types

There are many other types of contracts that are utilised in the construction industry however they are not as common as Construct Only and D&C, and for the purposes of having a practical case study, only these two contract types were considered as they feature predominantly on McNab Constructions sample of projects.

i) Lump Sum Construct Only

For a construct only project (where the client has already engaged the consultants prior to tender), a full package of design drawings and specifications are handed to the bidding contractor, and the contractor submits a lump-sum price to build to these documents. All RFIs need to be issued to the client (or superintendent, external project manager or client's representative) on this type of contact, as it is their design, for them to settle through their consultants that designed the project. It is this type of contract where RFIs can be delayed more-so than when dealing directly with the consultants working for the contractor. Communication can be lost if the RFI is not written well as communication is sometimes not direct with the consultant, which reduces the chance of receiving a preferred response. (Ross & Williams 2012)

ii) Design and Construct (D&C)

For D&C contracts, the Contractor takes the design risk and appoints their own consultants (Singh 2009). The bulk of the RFIs relating to the project are therefore issued directly from the contractor to the consultant for response, therefore the RFI will not actually go to the client on most occasions unless it will affect the end-user. Due to the fact that the contractor has appointed the consultant and thus essentially paying the people that are answering the RFIs, it is easy to manage the RFI process and enforce prompt responses. This is due to the fact that contractual conditions around RFI response times can be negotiated upon signing the consultancy agreement, and therefore penalties are enforceable for late responses. Communication is also possible directly with the consultants meaning RFI responses can be more favourable (Ross & Williams 2012). It is also common for correspondence between the contractor and their design consultants to be via general emails rather than RFIs depending on the relationship they have.

RFIs are still issued to the client on D&C jobs through the superintendent; however these are mostly during the design period. These RFIs are typically questioning '*what to build*' rather than '*how to build it*. Once the design is finalised and issued for construction, the client won't need to be issued RFIs in most instances.

iii) Construction Management Only

Sub-contractors are already appointed. Contractor will claim fixed margin overheads to manage the project.

iv) Guaranteed Maximum Price contract

A contract where the contractor guarantees the end price will not be exceeded. (Singh 2009)

v) Cost Plus or Schedule of Rates

Open book contract where all of the contractor's costs (materials and labour) are paid by the client, with an additional fixed margin also applied for overheads. (Ross & Williams 2012)

2.4.1.1 Contract Type for this Research

Studies suggest that the number of RFIs generated will be influenced by the contract type as this dictates heavily the arrangement for submitting RFIs, and the nature of the RFIs in general.

RFIs can be categorized into two major types depending on the nature of the information that is uncertain. Dombkins (2012) WHOW matrix has been adapted slightly below to help visualise the major differences between construct only projects and D&C projects, with respect to the types of RFIs as outlined below in figure 9.

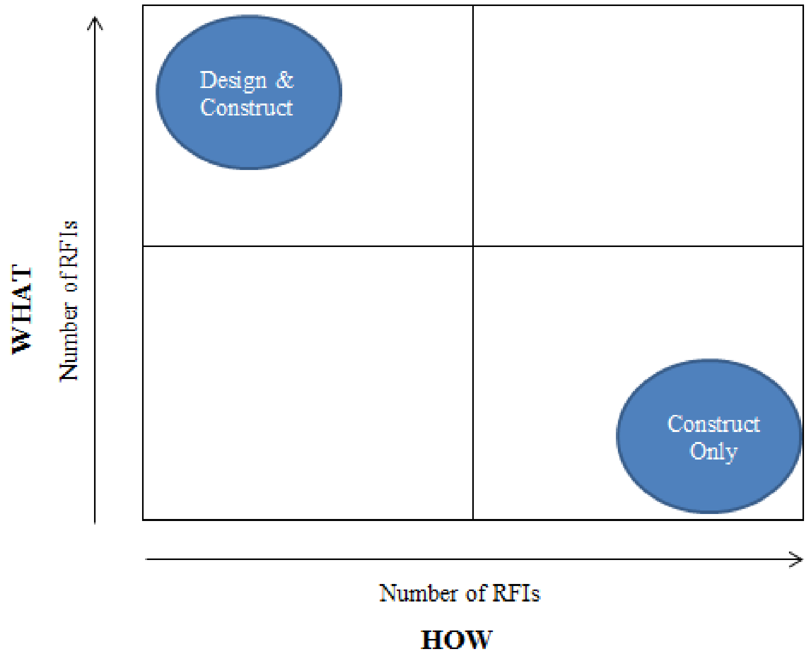


Figure 9 – Dombkin's WHOW matrix adapted to compare RFIs for Construct Only projects and D&C projects

Construct only projects require RFIs to be submitted for queries predominantly relating to issues of *'HOW to build it',* as the conceptualisation has been taken care of prior to engaging the contractor. D&C contracts however require RFIs to submitted to the client relating to issues of *'WHAT to build'*, mainly during the design phase, as the conceptualisation of the project is being dealt with. Client RFIs are not required for the technicalities of how to build, as these issues are dealt with by consultants who are appointed directly with the contractor. It is the *client* RFIs that are of particular interest in this research project.

As such, it was deemed not viable to delve into case study project databases containing a mixture of these contract types, as the RFI registers vary so vastly. For the databases available within McNab Constructions, the large majority of projects are Construct Only, and therefore all projects with other contract types are not considered from here-on-in. Selecting Construct Only projects was advantageous for this research project as it provided a larger sample size to study, as well as meaning that the results and conclusions are more beneficial to the major type of work that McNab Constructions engage in.

2.4.2 Project Size

It is predicted that the size of a project will have somewhat of an influence on the number of RFIs that it may be subject to. For the purpose of this research project, the project size is classified by a combination of its Contract Value, Gross Physical Area, and Project Duration, as outlined in the below sub-sections. While project size is a primary factor, each of these sub-factors will be taken on their own merits during the data collection as they are all project characteristics in themselves and can be analysed on their own.

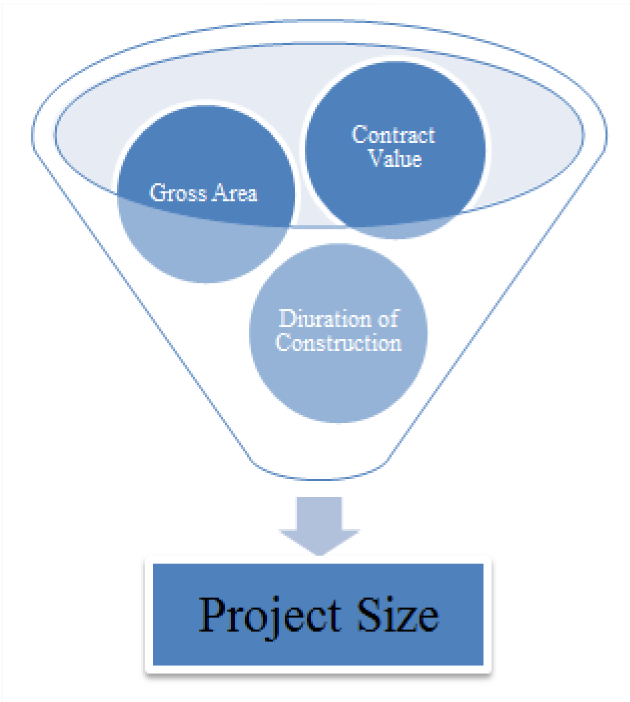


Figure 10 – Project characteristics that gauge the size of a project

i) Contract Value

Upon tendering for a project, the contractor is given a scope of work that should specify every element of work that they are to complete for the client. This scope of work ties hand in hand with the project design documentation, the terms and conditions of the contract and any other specific requirements that the client puts forward. In return, the contractor offers their price inclusive of all overheads and GST that encompasses the above and is perhaps negotiated to come to a final value, the contract value. Behind this single contract value is an estimated break down for all aspects of the project that was developed throughout the tender stage. This breakdown may or may not be requested by the client and will be used on a monthly basis to submit the contractor's progress claims as an accumulated percentage complete for each line item of the breakdown.

The contract value of a project is an important characteristic that is used to gauge how large or significant a project is, and will therefore be incorporated into the case study. A projects contract value is a dynamic figure that usually increases in size throughout the duration of the project due to variations. It is important to consider at what stage of the project the contract value is recorded at for the case study, as the original contract values will tell a different story to the final contract values of each project. The change in contract value on a project could be closely related with the number of RFIs encountered; however this analysis is outside the scope of this dissertation. Therefore to make this study as practical as possible and due to the objective of this study being to reduce the RFI impact on future projects, only the original contract values are to be considered for each of the projects in the sample. The contract value is used simply to gauge the project size in terms of the analysis that will be conducted in the ensuing chapter.

ii) Gross area (m^2)

Another factor that is used to gauge how big a project is its physical gross area. This is made up of the projects usable floor space and also includes any outdoor areas such as courtyards, car parks and landscaping. Having this is a project characteristic is important as the physical size of the build would indicate the amount of construction that is needed, and with the great construction area there would potentially lay more risk of having RFIs.

A constraint that this project characteristic has is that there is nothing to distinguish between the portion of car parking areas or landscaped areas from the actual building. There is less complexity in the construction details for these outdoor areas and therefore fewer chances of RFIs being required. This constraint is represented in figure 11 below, where these two projects both measure roughly 5,000 m^2 however it is evident that project B would be a more prone to RFIs than project A providing they are similar in every other characteristic. The proportion of building space rather than outdoor area, is higher on project B however and would be at a higher risk to more RFIs, however according to the project characteristic of project size, both jobs are considered equally.

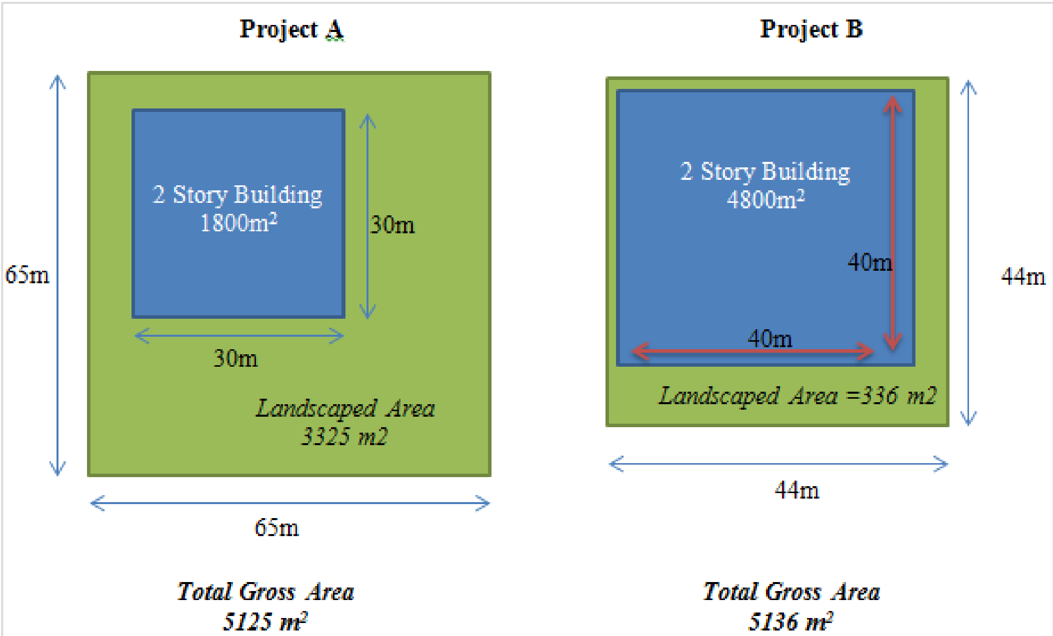


Figure 11 – Illustration of the constraint that is present for measuring project size

None-the-less it is still deemed worthy of using the gross area of the project as a characteristic to determine if there is actually a trend linking RFI numbers to projects' physical area.

iii) Duration of Construction (weeks)

The duration of construction is measured on a project by the development of the program, or schedule of events. The construction program will take into consideration any milestone dates as stipulated in the contract, and appropriate manpower needs to be incorporated to meet the dates as required. The project duration includes float as to counteract the inevitable unforeseen delays such as inclement weather and other latent conditions.

Much like a projects' contract value, its duration of construction can be estimated and locked into the contract between the contractor and the client. There is however likelihood that there will be fluctuations to the program and reductions or extensions of time will be applicable, and this could be caused by a number of factors. It is not uncommon for projects to be delayed significantly. For the purposes of this case study, the initial project duration will be recorded as well as the final adjusted project duration. For the most accurate results, both the initial and final durations will be recorded and an average taken to use for the analysis of data when relating the trend to the number of RFIs. The average will be taken due to the large variances on each project between the initial and final figures.

2.4.3 Project Type

The project type accounts for the various nature of construction methods that are used to achieve the end product. Due to the varying degrees of construction methodologies, procedures and materials throughout the different types of projects, it is important to distinguish the project types that are likely to receive more RFIs than others. Some project types are simplistic in nature and are not hard for the design documents to be close to 100% adequate. Some project types have inherent properties that mean perhaps significant amounts of RFIs are typically required, and it is these projects that need to be identified. The following sub sections categorize the projects that McNab Constructions commonly build into their project types, and these will form part of the case study in the ensuing sections.

i) Civil

Civil projects are ones that involve majority of works on ground level of below, usually involving heavy machinery and/or the placement of concrete or bitumen. Civil jobs are inherently large in area and can be said to lack the complexity of detail that is found in general construction projects.

Figure 12 – A photo of a Civil project - 150 Mega Litre Dam (McNab 2013)

ii) Commercial

Commercial projects are ones that are general construction projects usually incorporating tilt panel construction or block work with facades. They include retail centres such as Woolworths', Aldi's, small shopping complexes, showrooms and CBD multi story buildings etc. These project types have heavy requirements for the finishes both internal and external.

Figure 13 –Photos of Commercial projects (McNab 2013)

iii) Education

Education projects include school and university buildings consisting of single and multi-level construction, with clients from both private and government background.

Figure 14 –Photos of Education projects (McNab 2013)

iv) Government

Government projects are varying in nature with only the client in common. Construction can vary from Pools, Courthouses to Affordable Housing Developments.

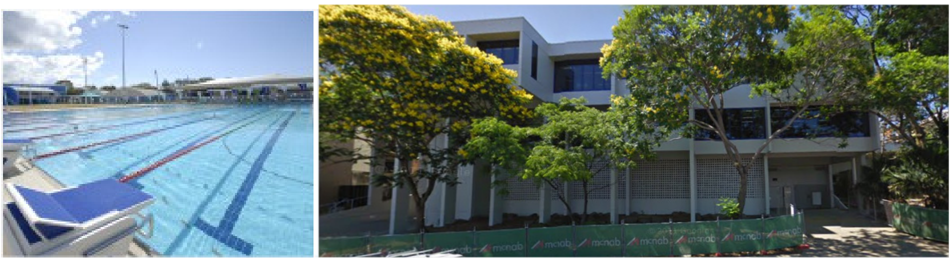


Figure 15 –Photos of Government projects (McNab 2013)

v) Industrial

Industrial projects consist of warehouse type constructions, typically heavy duty structural steel portal frame with either cladded or tilt panel walls with large amounts of concrete floor area.

Figure 16 –Photos of Industrial projects (McNab 2013)

vi) Residential/Retirement

Residential/Retirement projects are often multi-story developments however they can be an array low-set dwellings. The level of services throughout these projects is large with electricity, hydraulic and mechanical required throughout each unit or complex. There are lots of details throughout however much of these are replicated in each room and on each story.

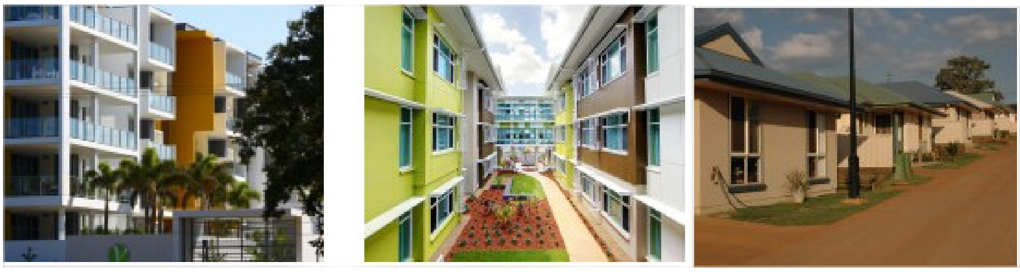


Figure 17 –Photos of Residential/Retirement projects (McNab 2013)

2.4.4 Project Complexity (Number of Drawings)

Project documentation comes in the form of Plans, Specifications and Schedules that should detail every element of construction. The documents are maintained in project registers and all documents are susceptible to change where required. Drawings will be revised to show amended details if an RFI is issued that highlights a design deficiency or constructability issue. New documents can be issued and often a project will have many new documents by the end of construction than when it first started. This change in number of documents could be related to the number of RFIs that were submitted on the job however investigating this relationship falls outside the scope of these works, and has been highlighted as future studies in section 5.3 accordingly.

For the purpose of this case study, project complexity is measured by the number of drawings that the project has across all disciplines of design. The more drawings that the project has, indicates that there could be more risk for RFIs due to there being more room for error from the design consultants to miss something out or have a contradiction amongst the drawings. A large amount of project drawings could also be indicative of a thorough design.

It is however a project characteristic none-the-less and will be investigated for a trend linking it to RFI numbers.

2.4.5 Year of Construction

There is no doubt that certain elements of construction has developed significantly over the years and this can be put down to a number of factors. In a changing industry, it is therefore important to keep this case study as relevant as possible in the realms of today's world, this will ensure the study stays applicable for as many years to come as possible.

As mentioned in section 2.2.2, the advancements in technology have had the most significant impact in the context of this case study. New technologies have impacted on the way that project correspondence is distributed, and the way design consultants produce their documents, and this bears a large influence on this dissertation. As such, parameters have been set on the available sample data to ensure projects are captured that share today's similarities with respect to the construction industry.

In today's construction industry, there is more onus on the accuracy of documentation than in the past where all aspects of the job may not have been documented. This would have had significant impact on what would and would not have been questioned in RFIs.

By setting a parameter of only considering projects over the past five years (back to 2009), it can also be said that project data is more accessible due to electronic storage and in addition to this, documented more thoroughly as the scrutiny on projects has increased to meet evolving client requirements.

2.5 Root Causes of RFIs

RFIs are extremely simple in nature and can only be issued as a result of a select number of root causes. Even though these root causes (outlined in the sub sections below) are simple, they are very common in the construction industry and must be understood in order to reduce the impact of RFIs.

2.5.1 Design Deficiency

In an ideal world RFIs would not be needed as design drawings and specifications would be 100% adequate to not need any further clarification or information. During the construction phase however, it is inevitable that clarifications are needed, possibly from human error, or from design documentation that is incomplete, conflicting or Erroneous (Mohamed, Tilley & Tucker 1998). Some of the design deficiencies that commonly result in RFIs are when the design;

- Contradicts itself between different documents
- Excludes information that are required for construction
- Incorrect elements of design
- Clash of services/members/details between the various design disciplines
- Nominated products are not ideal – better alternatives out there

Studies have been conducted (Tilley, McFallan & Tucker 1999) that provide lead indicators for measuring design and document deficiency and this is achieved through investigating drawing registers and RFI registers, however for the purpose of this study, realising the fact that design deficiency exists is sufficient.

It is often the case that only once construction begins that these design flaws are made aware to the contractor or subcontractor. At this stage in the project, delays are exaggerated due to increased costs from having more overheads and resources being stood-down or not utilised to 100% efficiency on-site.

Consultants, like other companies, have budgets to adhere to and trying to minimise expenditure is critical for them to remain profitable. This can come at the expense of how thorough their design documentation is. The consultants have a level of comfort that even if they do not document every element of the project, the contractor will pick up the issue at construction stage. Essentially this means the consultant has got away with the expense designing the issue upfront. The performance of consultants in general is discussed in section 4.2.2 as part of the circumstantial factors behind RFI impact.

2.5.2 Constructability issues

Having a project that is easily constructible is a good thing as it means there are economic efficiencies due to the speed and simplicity of the project. Constructability is more generally defined by Construction Industry Institute (1986) as "the optimum use of construction knowledge and experience in planning, engineering, procurement and field operations to achieve overall objectives". For the purposes of this element of the research project, constructability issues relate to the elements of the design that are timely, expensive or simply not constructible.

This is a root cause of RFIs, and these issues come down to the diligence that the consultants have shown when preparing their design documents. Being able to detect constructability issues comes with experience and is harder to target when strategizing to reduce numbers of RFIs (Jergaes & Van der Put 2001).

2.6 Impact of RFIs - Time & Cost

Studies show the man-hours spent on RFIs can be onerous for subcontractors, contractors, consultants and the client. It is easy to see how costs accrue rapidly when any given RFI typically has input from the following people at a minimum, all spending some amount of time to brain storm, collaborate, research, calculate, draft and finalise an RFI just to submit it and then respond to it. Figure 18 below represents the personnel that typically have some form of role to play in the RFI process.

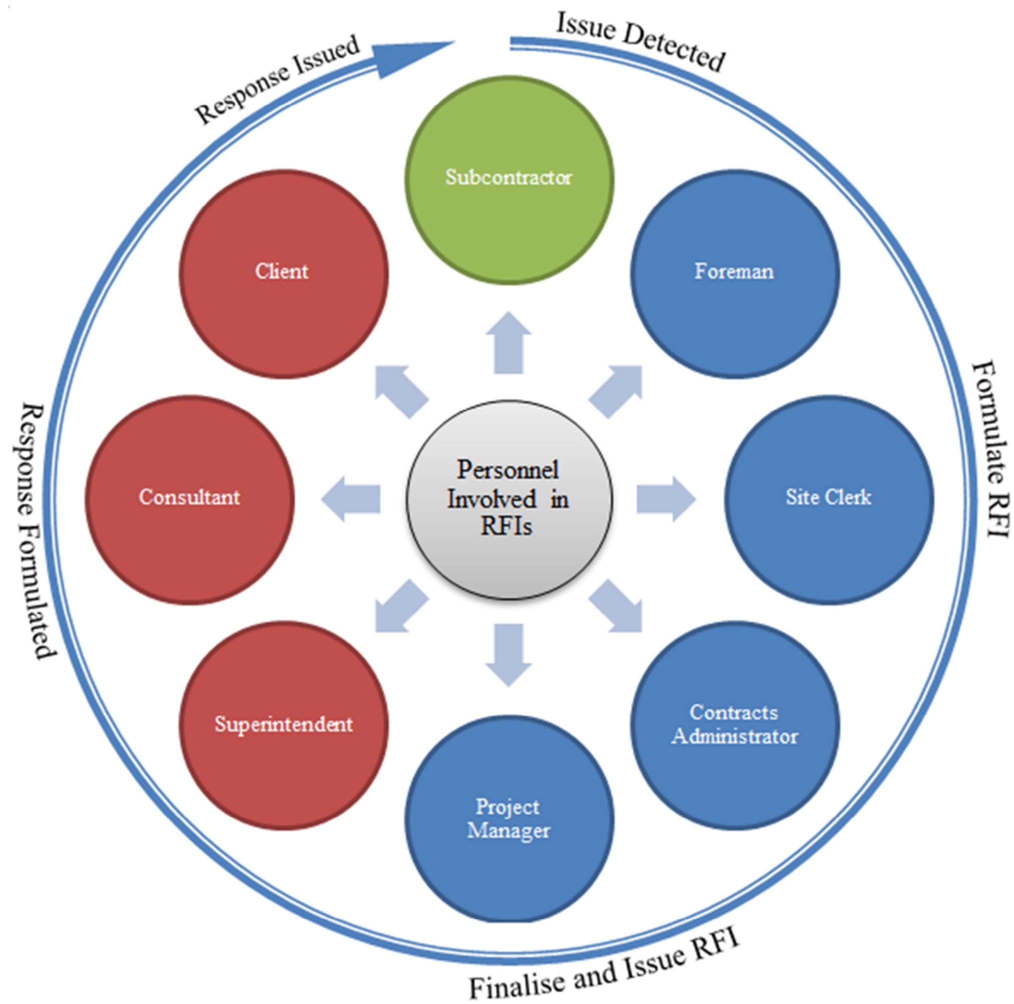


Figure 18 – Personnel involved in RFIs (Mohamed, Tilley & Tucker 1998)

The cycle time was estimated for a typical RFI in 1998 (Mohamed, Tilley & Tucker 1998) according to the time spent for each of the above personnel and taking into consideration their hourly rates, 17.3 hours totalling $1,379 was the cost calculated for completely processing an RFI. Considering just the contractors impact out of these figures (excluding subcontractor, superintendent, consultant hours), 6.44 hours were spent at a total of $486. The introduction of technology and general gains in efficiencies in the 15 years since this study, these costs will now be less; however the impact is evident none-the-less. This research project will not quantify the costs in today's industry however it will use the assumption that there are significant costs associated with the RFI process, and look to create efficiencies to impact the RFI process and try to reduce the number of RFIs on future projects.

The common element between all RFIs is the associated lost-time as a result of the process. Compounding this above cost impact, is the tracking the RFIs through the use of the register and chasing responses, this consumes resources and therefore time and cost. In today's society when organisations are typically under resourced, as opposed to over resourced, it is common for RFI responses to be late, vague, possibly missing important pieces of information and sometimes late or forgotten if they are not chased properly. Section 3.6.6 refers to Appendix G which is a further case study into late RFI responses on a particular project that forms part of the sample, referring to Appendix G shows the common late RFIs are on projects. These problems lead to the need for contractors to re-issue of the same (or similar) query on a revised RFI which exaggerates the time and cost spent to a higher degree (Mohamed, Tilley & Tucker 1998).

Another impact with regards to RFI responses is the issuing of additional documentation as a result (Tilley, McFallan & Tucker 1999). This creates additional work on the administrative personnel to control these additional documents. Time is lost entering these documents into the document control system and issuing to the subcontractors and updating document sets in the office and on-site.

A large impact is derived from the changing design as the project continues. These changes cost money and the further in the construction it is, the greater the cost, as illustrated in figure 19 below. While RFIs have been submitted and decisions are pending, there is potential discontinuity of works on site and a disruption to the procurement of materials which causes significant impact. The ability to forecast costs and sequence works as a result is disrupted. It is preferable for all design changes to occur at the start of the project.

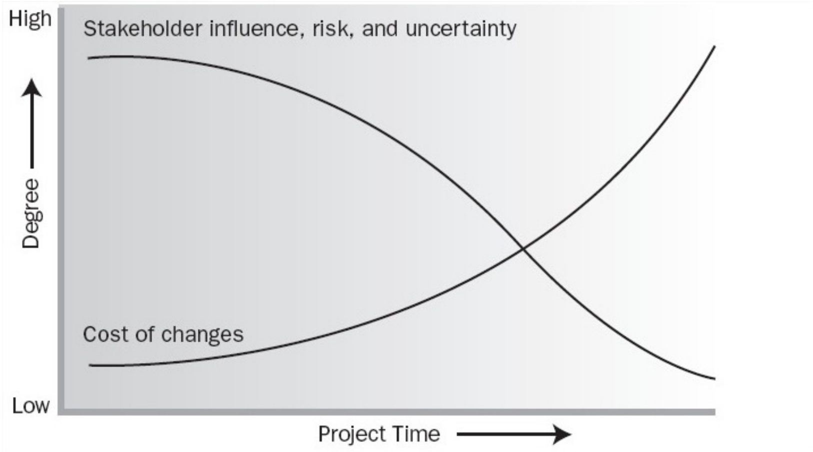


Figure 19 –Cost Implications throughout Project Life Cycle (Defranco 2010)

It is quite possible that the submissions of RFIs are not 100% efficient due to workloads of the project personnel. If an RFI sits with a particular person without action for even one day, this impacts the project as RFIs are critical to submit as soon as possible. Related to this is the efficiency that the contractor chases up the pending RFIs and keeps the communication flowing to the client/consultant that they are waiting for the RFI response.

RFIs also often lead to site instructions and therefore variations for additional work which is not favourable for the client as the contractor can add additional margin as the client has no real other option other than to approve the price for the additional work that results from the RFI. This will be discussed in section 2.7 below.

RFIs facilitate clarifications that are only technical in nature - that is, relating to the design drawings/specifications or the constructability of the design. Clarifications of any other nature (such as contractual issues or approvals) need to be separated from RFIs by using another form of correspondence. It is not uncommon for RFI registers to be miss-used due to their effectiveness to track and force prompt responses from the client. Contractors can stretch the definition of 'technical' and try to ask contractual questions on an RFI, which leads to the rejection of the RFI which is not beneficial for any party as it costs time, money and resources (Mohamed, Tilley & Tucker 1998).

The bottom line is that if the design documentation was adequate in the first place there would be no need to raise the query in an RFI and therefore no additional costs would be spent and variations would not be needed.

2.7 Flow-On Effect of RFIs

As mentioned in section 2.6, RFIs impact the ideal flow of construction some-what. In addition to the impacts as listed, the significance of the flow-on effects cannot be ignored.

If an element of unknown is questioned by the contractor, there is likelihood that as a result the contractor will be required to complete works that were not outlined in the original scope of works. In order for the contractor to undertake these works, they must be issued a 'Site Instruction', which is a contractual notification to proceed with the additional works. Related to this site instruction will be a variation to the contract. Depending on the nature of the site instruction, the variation may or may not need to be submitted and approved by the client to agree on the price, prior to proceeding with the works.

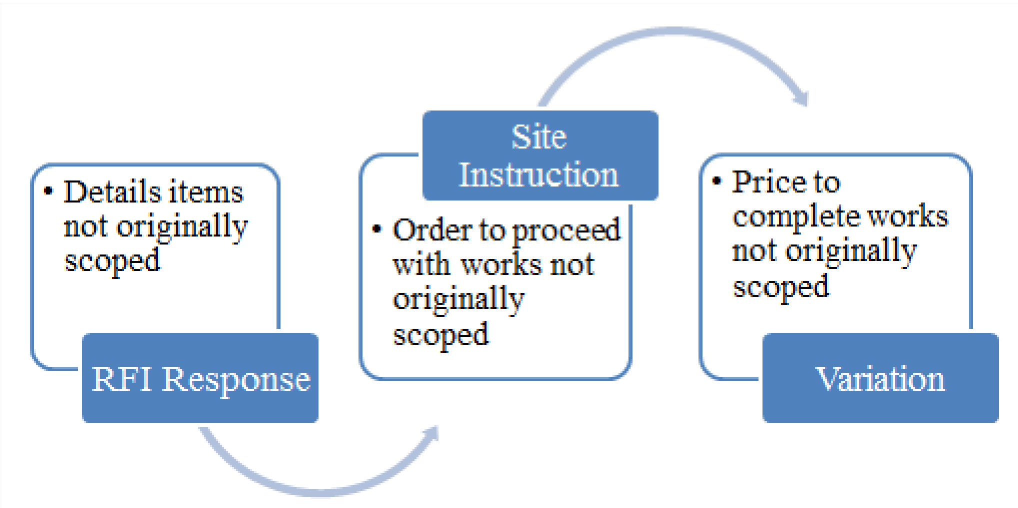


Figure 20 – Diagrammatic view of the flow-on effects of RFIs

Not all variations stem from RFI responses, however if considering the total of all variations that do, this is a gauge on how much impact has come as a result of the RFIs, in addition to the unavoidable impact from the factors outlined section 2.6.

Studying the relationship between these flow-on effects has been outlined as future works however they are important to consider when looking at overall impact that projects are succumbed to as a result of the RFI process.

CHAPTER 3 –METHODOLOGY

3.1 Overview

In order to achieve the project objectives to minimise the impact of RFIs, the following methodology has been proposed and implemented.

- Obtain a sample of real projects to conduct a case-study.
- Set parameters that ensure the data obtained from the sample is relevant to the study.
- Conduct a case-study on each of the sampled real projects and record the relevant characteristics necessary for analysis.
- Tabulate the data obtained and present graphically; show basic statistical information for each project characteristic in order to understand the sample projects.
- Manipulate the data to identify key project characteristics that are most commonly evident on jobs that have had high numbers of RFIs.
- Filter the sample of projects to just those that demonstrate above key characteristics. Further obtain data pertaining to each RFI issued for each of these projects.
- Using this specific information, develop strategies to minimise the impact of RFIs for future 'high risk' projects.

3.2 Parameters of Sampled Projects

In order for the analysis of this study to be applicable for construction contractors to contemplate, it is important to consider the properties of the data and the project characteristics that make up the sample data, of which will have certain parameters. Considering these parameters, it will dictate the applicability of the results for companies other than McNab Constructions. If another company's project type differs dramatically from the projects as described in the below parameters, they will be unable to utilise the results as the data will be out of context. For the scope of this study and for the time and resources available, it is intended for the purpose of McNab Constructions to utilise only as all of the data is obtained from their database, and hence is applicable for implementing the concluding strategies.

The data obtained for this research project was made available by McNab Constructions, a mid-tier Construction company based throughout Queensland. McNab Constructions were established 16 years ago in Toowoomba where they were involved primarily in small agri-business projects. Over the years McNab have developed into a successfully expanding business that undertake projects for a multitude of clients throughout several construction sectors. "With over 80% of business from repeat clients, McNab is a civil and construction contractor of choice on Australia's leading energy, resource and commercial projects" (McNab 2013).

The parameters that govern the range of data available are set out below for each project characteristic, which sets a level of relevance that would be of benefit for other Contractors who are engaged in similar facets of construction.

The selected projects that the sample data was obtained from, exhibit the following parameters as outlined in each of the below sub sections.

3.2.1 Contract Type

Construct Only (Lump Sum)

The majority of McNab's projects are engaged as Lump Sum Construct Only, with the exception of the occasional Design and Construct contracts. In order to gain the most benefit out of this study, it was deemed appropriate to only take into consideration the Construct Only contracts. It would have been difficult to maintain an adequate sample size of projects if Construct Only contracts were excluded. The data would also have been misleading if Construct Only projects were mixed into the same sample as Design and Construct project, as the nature of the RFIs differ dramatically between these two types of projects and it would be un-fair to assess their RFIs together. For the purpose of this study, all other contract types are not further considered in this report.

3.2.2 Project Types

Civil, Commercial, Education, Government,
Industrial, Residential/Retirement

McNab engage in Civil, Commercial, Education, Government, Industrial and Residential/Retirement project types. It is expected that the number of RFIs on a project will be largely governed by the project type. For the purpose of this study, project types other than these, are not further considered in this report.

3.2.3 Project Value

$0.6 million - $34 million

The sample size of projects range between $0.6 million and $34 million. This parameter gives a large amount of context about the size of projects sampled. It is expected that project value will factor majorly for RFI numbers and thus will be one of the characteristics studied further in this project.

3.2.4 Year of Construction

2009 to present

This is due to the technological era playing a significant role on the RFI process and thus taking a sample of projects since 2009 only, excludes projects where RFIs may have been faxed, mailed or delivered in hardcopy. If projects were considered prior to electronic distribution of documents and RFIs, the data could be somewhat out of context as the modern era has seen electronic distribution of data become main stream. For the purpose of this study, the year of construction is not further considered in this report.

3.2.5 Location

Queensland (Northern, South-Eastern and South-Western)

The sample of projects include only Queensland based projects from the North, down to the South-East and the South-West pockets of Queensland. Refer to Figure 21 below for a graphical representation. This includes projects based in metro CBD, industrial suburbia, and remote/rural locations. The site of a project may or may not have an influence on the number of RFIs; however this factor gives the sample data some context none-the-less. For the purpose of this study, the locality of each project is not further considered in this report.

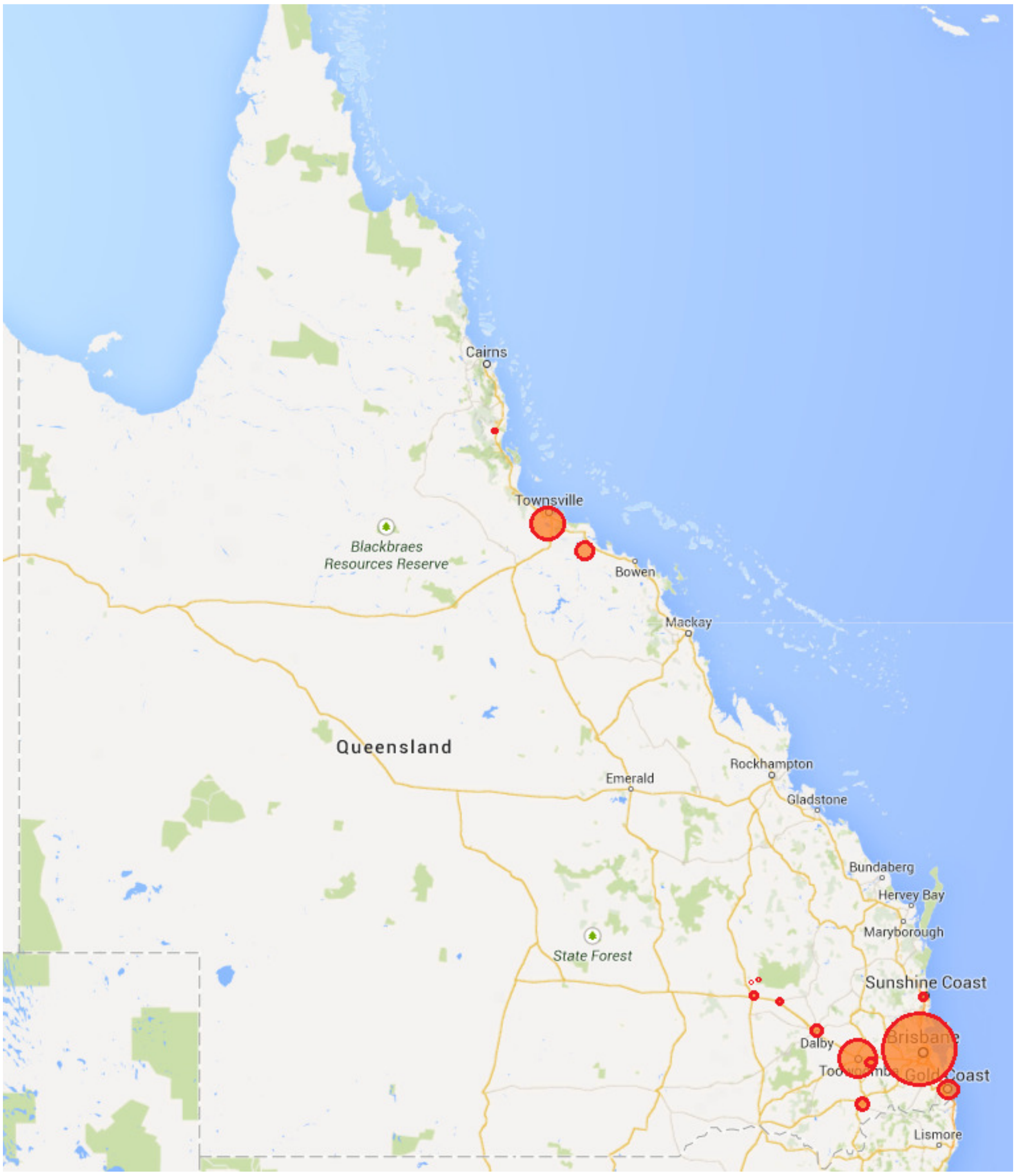


Figure 21 – Distribution of project locations around QLD (Google Maps 2013)

3.2.6 Number of Projects

48 Projects

Considering the above parameters, the sample size able to be investigated is 48 projects and as such it is expected that reliable statistics for analysis purposes will be achievable.

3.3 Data Collection

For the 48 projects with parameters mentioned in section 3.2, further information was collected for each project and is outlined in the ensuing sub-sections.

Appendix F shows the matrix of accumulated data prior to manipulation. The collation of data was completed using Microsoft Excel as it can be manipulated and sorted with ease using the filters function, and graphed/plotted accordingly.

By gaining access to each of the job files at McNab Constructions and finding the information, the following project characteristics were inputted manually;

- Contract Value
- Project Size (physical area)
- Project Duration (an average of the expected duration as found in contract and the final duration as found in project construction schedules)
- Project Complexity (number of drawings)
- Project Type
- Number of RFIs

There are additional factors that could have been recorded for each project that may or may not have had an influence on the number of RFIs a job experiences. Recordable characteristics could have included the number of project personnel on the job, location of construction, number of site instructions, number of variations submitted, total increase in dollars between the contract sum and the summated value of all variations etc.

For the purposes of this study however, the selected project characteristics as dot pointed above, were deemed most effective due to their simplicity, and also due to the fact that all of these characteristics will be known prior to the commencement of construction of future projects that are awarded to McNab Constructions. This is an extremely important factor as the objective of this study is to use the historic information in order to reduce the impact of RFIs on future projects. By revealing the key project characteristics that stimulate large amounts of RFIs, strategies can be made to limit the number of RFIs prior to the project commencing.

The ensuing sub-sections outline the properties of the sampled data for each characteristic.

3.3.1 Contract Value

Contract values are formulated through the tendering process in the contractors attempt to win the job. The balance must be made between offering the lowest possible price in order to be the cheapest tenderer, while maintaining an acceptable profit margin in order to be sustainable as a company. If the contractor is successful in their tender price, the contract will be signed for that exact amount of money and are expected to complete the portion of works that were outlined in the project documentation. Anything outside of those realms forms a valid variation and extension of the contract value. For the purposes of this study it is the original contract value that is being measured, as obviously this is the value that is known prior to construction commencing and will be of most benefit when applying the impact-reducing strategies.

Using the data collected, a brief statistical analysis was done to consider the nature of the 48 projects in terms of their Contract Values.

Figure 22 below graphically shows the spread of data sorted in ascending order of contract value;

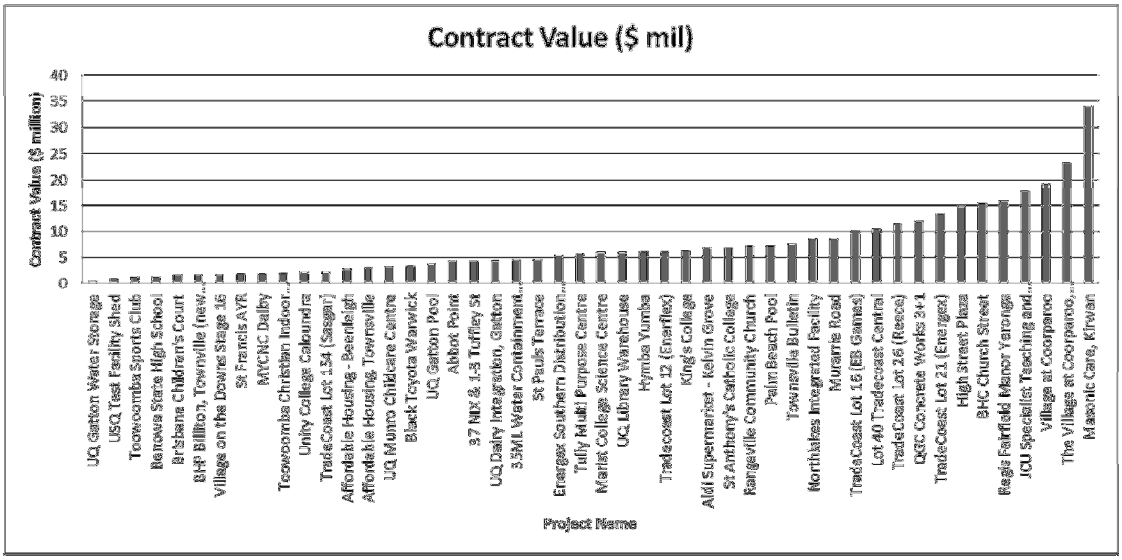


Figure 22 – Data Collection for Contract Value

When plotted as a histogram, the following spread is revealed in figure 23 below;

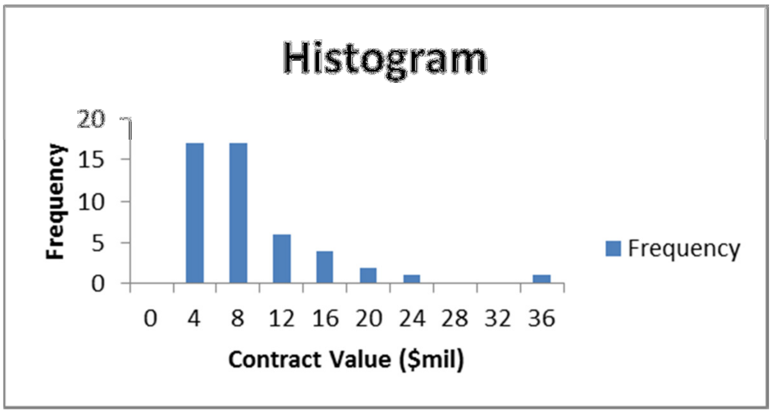


Figure 23 – Histogram for Contract Value Data

The statistics are shown below in table 1.

Table 1 – Statistics for Contract Value Data

Contract Value ($ million)	
Average	7.36
Minimum value	0.6
Maximum Value	34
Median	5.85
Std Dev	6.57
Skew	1.96
1st quartile	2.75
3rd quartile	9.075

3.3.2 Project Size

For the purpose of this study, project size is deemed as the gross physical usable area of the project. This includes landscaped areas, driveways, car parks and the inside of the structure.

Using the data collected, a brief statistical analysis was done to consider the nature of the 48 projects in terms of their Project Sizes.

Figure 24 below graphically shows the spread of data sorted in ascending order of project size;

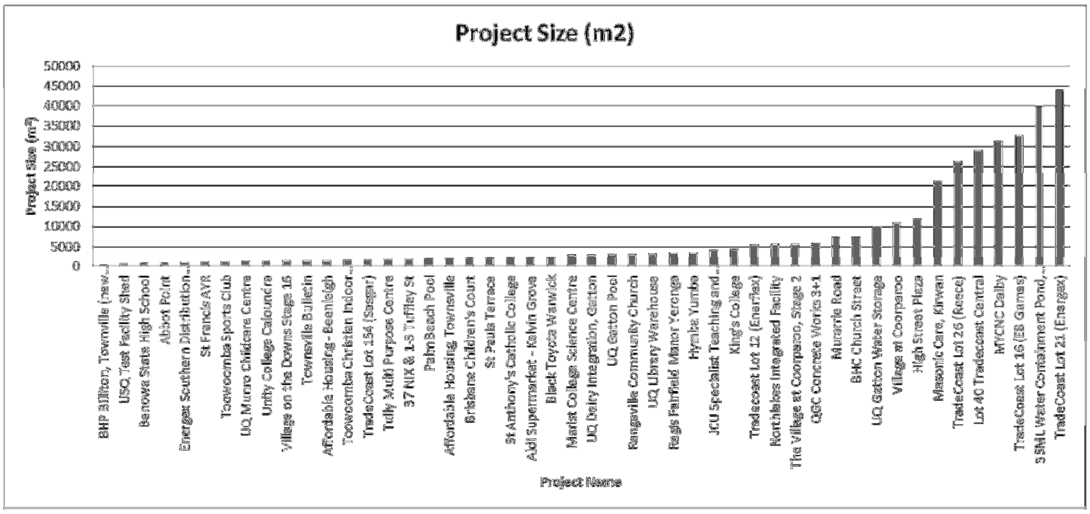


Figure 24 - Data Collection for Project Size

When plotted as a histogram, the following spread is revealed in figure 25 below;

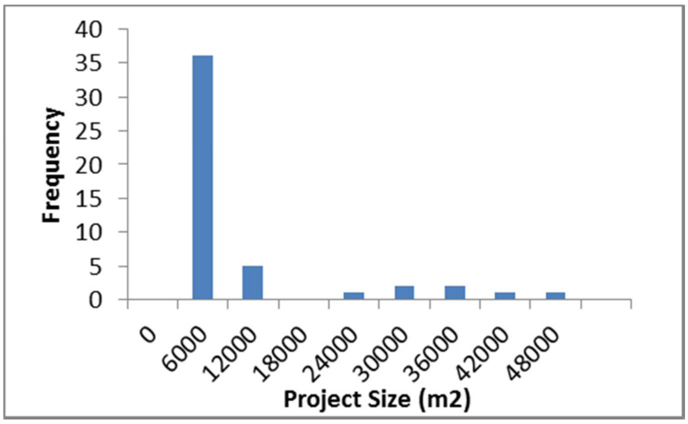


Figure 25 - Histogram for Project Size Data

The statistics are shown below in table 2.

Table 2 - Statistics Histogram for Project Size Data

Project Size (m2)	
Average	7543
Minimum value	360
Maximum Value	43900
Median	3067
Std Dev	10934
Skew	2.13
1st quartile	1593
3rd quartile	6360

3.3.3 Project Duration

Project Duration was measurable by gauging firstly the original expected duration of the project as set out in the contract, and secondly, the actual duration was recorded as per the construction schedules towards the end of the project. While in some instances these two values differed by large amounts due to unforeseen project delays or accelerations, the importance was to find a balance between the forecast and the actual for the sole purpose of trying to ensure the data is reliable. These values were therefore averaged and analysed accordingly.

Using the data collected, a brief statistical analysis was done to consider the nature of the 48 projects in terms of their Project Duration.

Figure 26 below graphically shows the spread of data sorted in ascending order of project size;

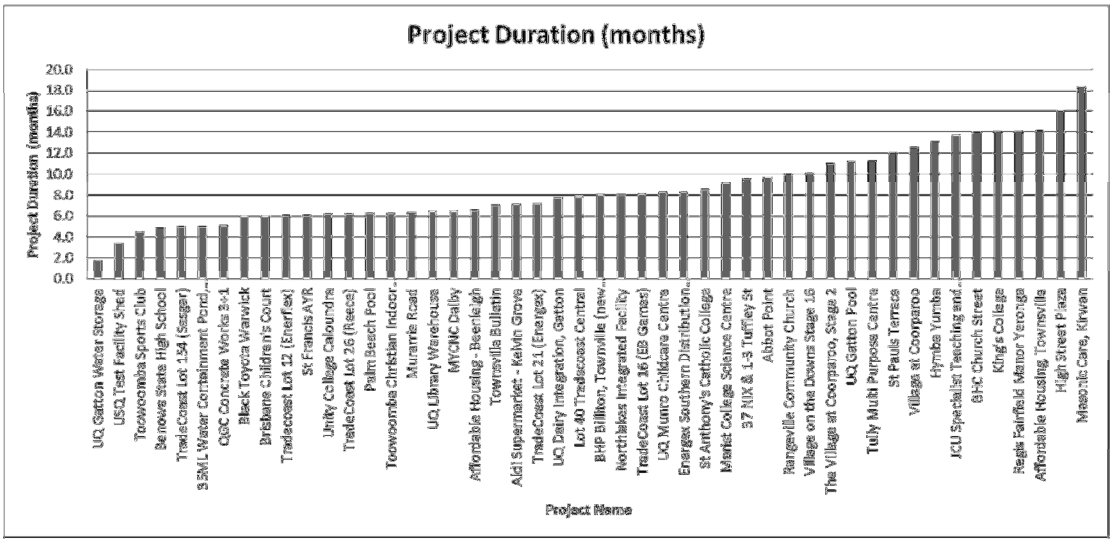


Figure 26 – Data Collection for Project Duration

When plotted as a histogram, the following spread is revealed in figure 27 below;

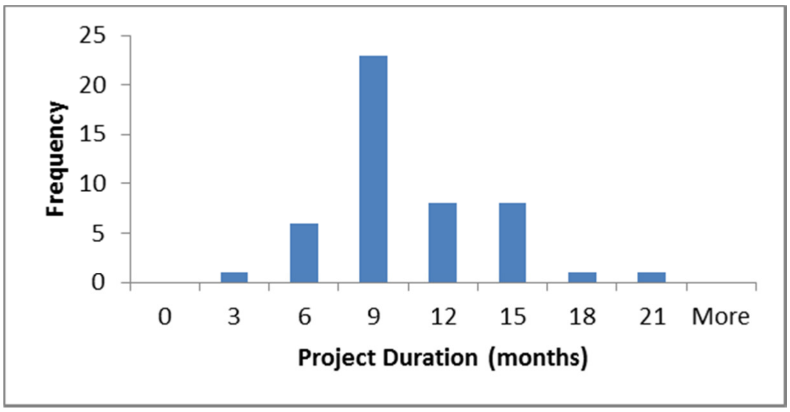


Figure 27 – Histogram for Project Duration Data

The statistics are shown below in table 3.

Table 3 - Statistics for Project Duration Data

Project Duration (months)	
Average	8.66
Minimum value	1.75
Maximum Value	18.38
Median	7.9
Std Dev	3.55
Skew	0.71
1st quartile	6.2
3rd quartile	11.11

3.3.4 Project Complexity (number of drawings)

Having a gauge of each jobs complexity is important as this could very well affect the number of RFIs on the project. The project complexity is measured by the number of project documents (drawings and specifications) that are on the job. This is on the basis that a project having a considerably large amount of design detail, would be open for more opportunity of conflict/error and hence require more RFIs.

Using the data collected, a brief statistical analysis was done to consider the nature of the 48 projects in terms of their Project Complexity.

Figure 28 below graphically shows the spread of data sorted in ascending order of Project Complexity;

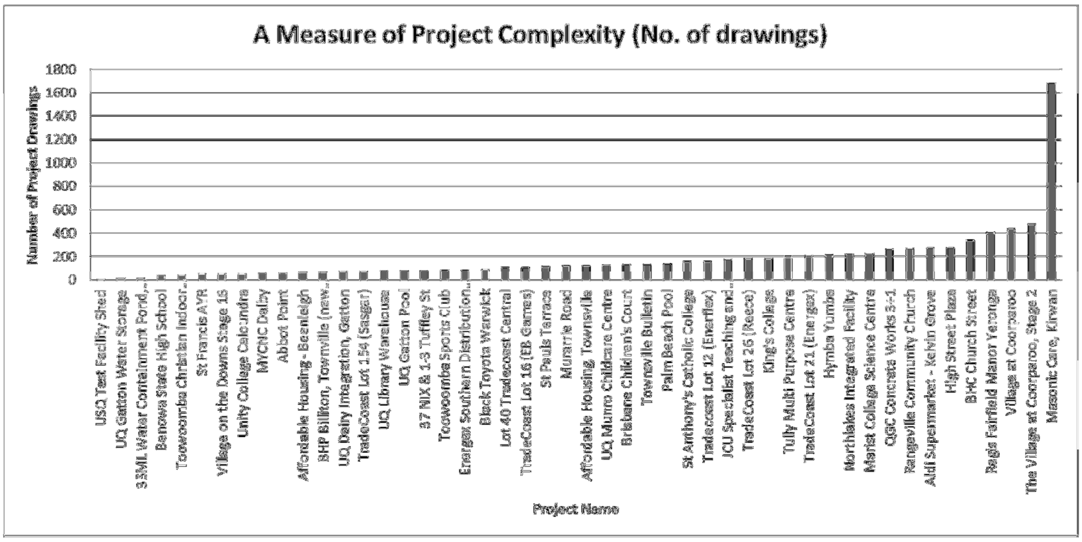


Figure 28 – Data Collection for Project Complexity

When plotted as a histogram, the following spread is revealed in figure 29 below;

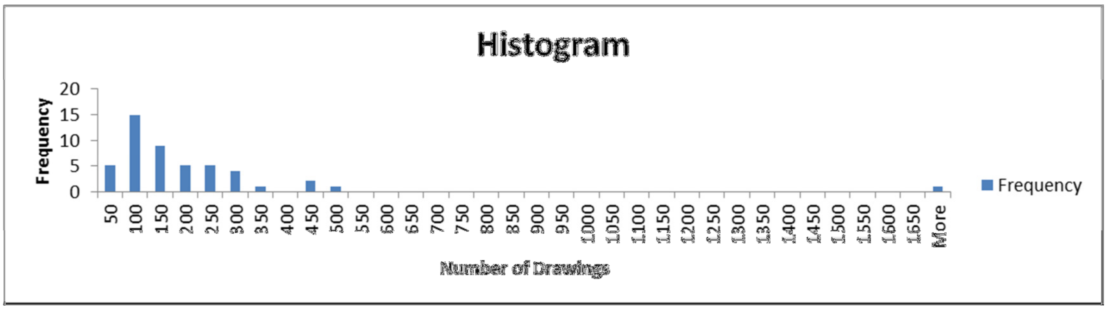


Figure 29 – Histogram for Project Complexity Data

The statistics are shown below in table 4.

Table 4 - Statistics for Project Complexity Data

Project Complexity (No. of Drawings)	
Average	184
Minimum value	10
Maximum Value	1684
Median	127
Std Dev	247
Skew	5
1st quartile	73
3rd quartile	217

3.3.5 Project Type

The nature of the project being undertaken is largely attributed to what style of project it is. A civil earthworks job has an extremely different make-up of properties in comparison to a Residential/Retirement job in a CBD. It is therefore expected that the detail design differs largely between the types of construction and therefore also the need to submit RFIs.

Using the data collected, a brief statistical analysis was done to consider the nature of the 48 projects in terms of their Project Types.

When plotted as a histogram, the following spread is revealed in figure 30 below;

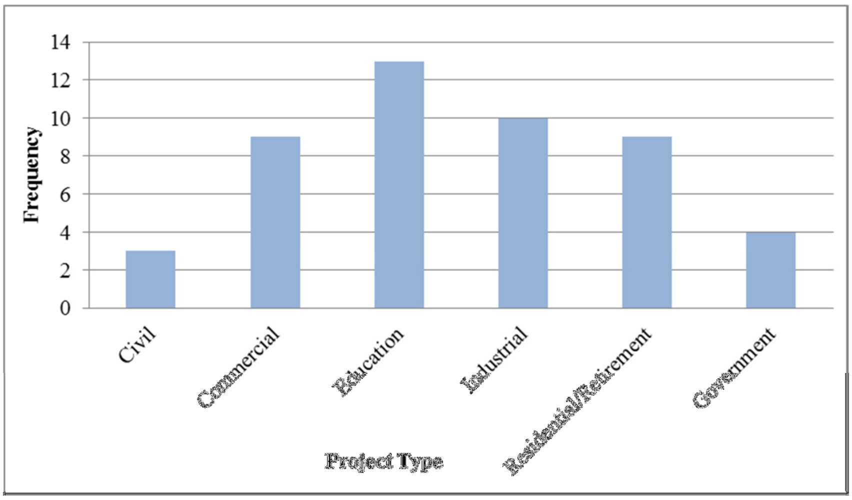


Figure 30 – Histogram for Project Type Data

The statistics are shown below in table 5.

Table 5 - Statistics for Project Type Data

Project Type	Frequency
Civil	3
Commercial	9
Education	13
Industrial	10
Residential/Retirement	9
Government	4

3.3.6 Number of RFIs

Using the data collected, a brief statistical analysis was done to consider the nature of the 48 projects in terms of their Number of RFIs.

Figure 31 below graphically shows the spread of data sorted in ascending order of Number of RFIs;

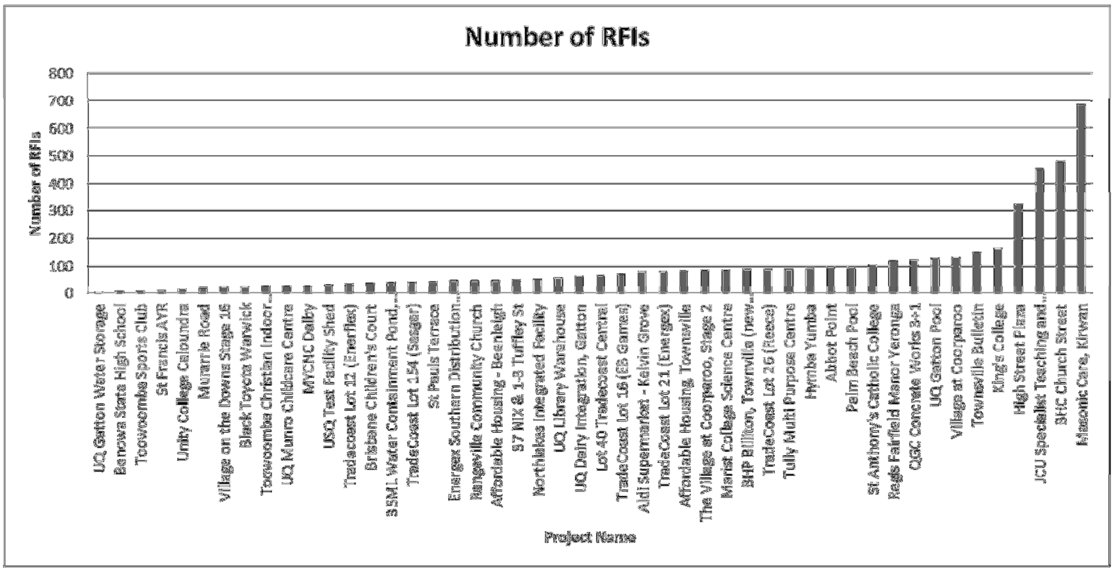


Figure 31 – Data Collection for Number of RFIs

When plotted as a histogram, the following spread is revealed in figure 32 below;

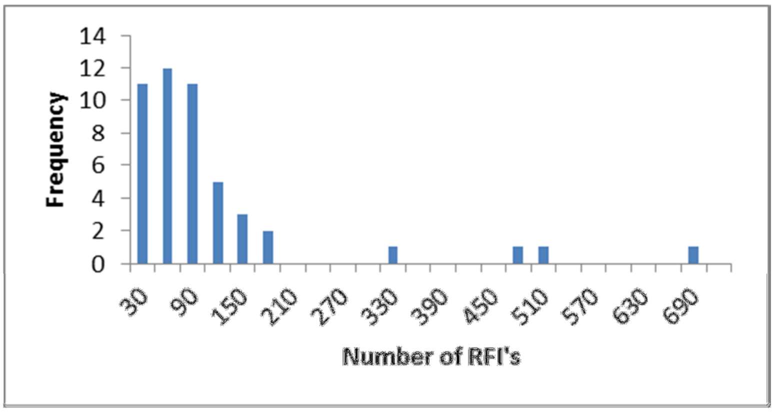


Figure 32 – Histogram for Number of RFIs Data

The statistics are shown below in table 6.

Table 6 - Statistics for Number of RFIs Data

Number of RFIs	
Average	99.23
Minimum value	4.00
Maximum Value	687.00
Median	65.5
Std Dev	129.89
Skew	3.11
1st quartile	36
3rd quartile	94.25

3.4 Data Manipulation

In order to determine which of the above characteristics have the strongest correlation to the projects which show high number of RFIs, the following analysis has been carried out for each characteristic;

- Visual (graph of the project characteristic ranked in ascending order (as per the sub-sections of section 3.3), with the respective graph directly below it with the projects in the same order, showing RFI numbers). The strength of the visual trend is evident.
- Statistical - Upper Quartile analysis (the average number of RFIs per project is 99 RFIs. If only considering the Upper Quartile range of the project characteristic, the average RFI is taken again and the larger the deviation from 99 RFIs, the stronger the characteristic is).

In the ensuing sub-sections, these two listed analyses are carried out for each project characteristic.

3.4.1 Contract Value

The visual trend is shown below in figure 33, when re-producing the plot from section 3.3.1 and displaying directly below it the correlating number of RFIs for each project ranked in the same ascending order by Contract Value.

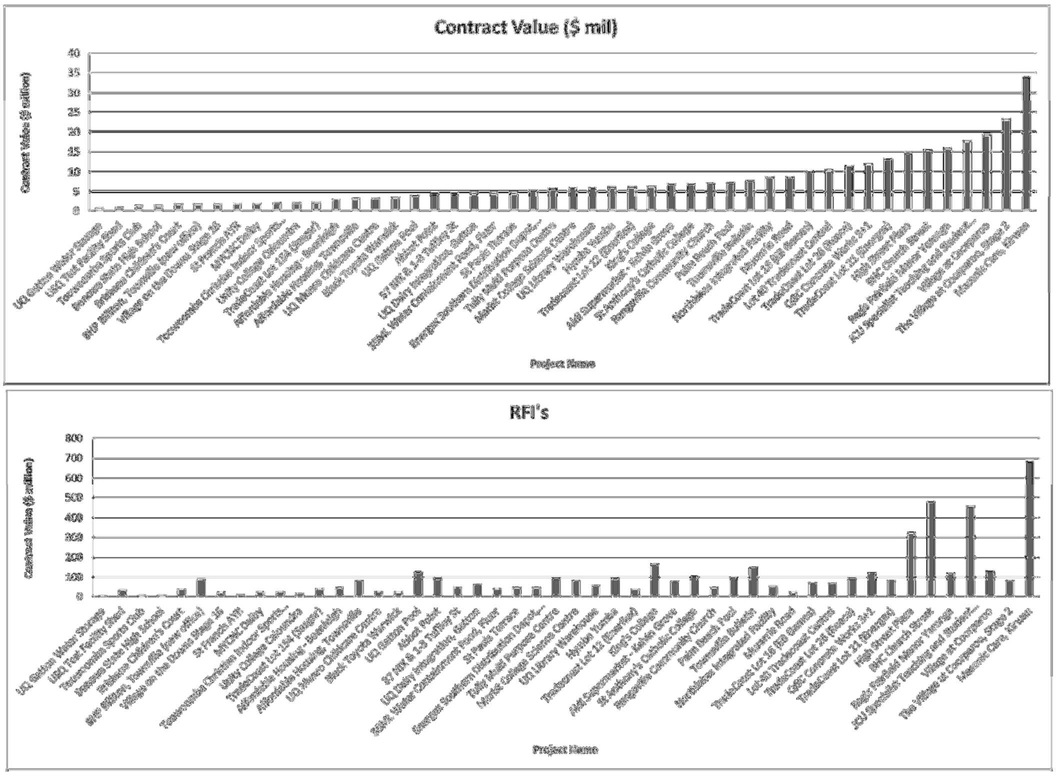


Figure 33 – Visual trend for Contract Value verses number of RFIs

The statistical analysis below in table 7 and table 8 reveals that when taking just the;

- Lower quartile of data when ranked in Contract Value (average $1.67 mil), the average number of RFIs is just 27, a difference of -72%.
- Upper quartile of data when ranked in Contract Value (average $16.51 mil), the average number of RFIs is 226, a difference of +226%.

Table 7 – Lower and Upper Quartile display of sample of data for Contract Value

Lower Quartile of data		Upper Quartile of data	
Contract Value ($ mil)	RFIs	Contract Value ($ mil)	RFIs
0.6	4	10.2	71
0.9	33	10.5	67
1.4	7	11.5	89
1.4	7	12	123
1.7	38	13.4	81
1.8	88	14.7	324
1.8	25	15.5	481
1.9	11	15.9	119
1.9	27	17.8	455
2.1	26	19.3	130
2.2	17	23.3	85
2.3	41	34	687

Table 8 – Lower and Upper Quartile comparison for Contract Value

	Average # of RFIs	Percentage change
All Data	99.23	
Lower Quartile of Data	27.00	-72.79
Upper Quartile of Data	226.00	127.76

3.4.2 Project Size

The visual trend is shown below in figure 34, when re-producing the plot from section 3.3.2 and displaying directly below it the correlating number of RFIs for each project ranked in the same ascending order by Project Size.

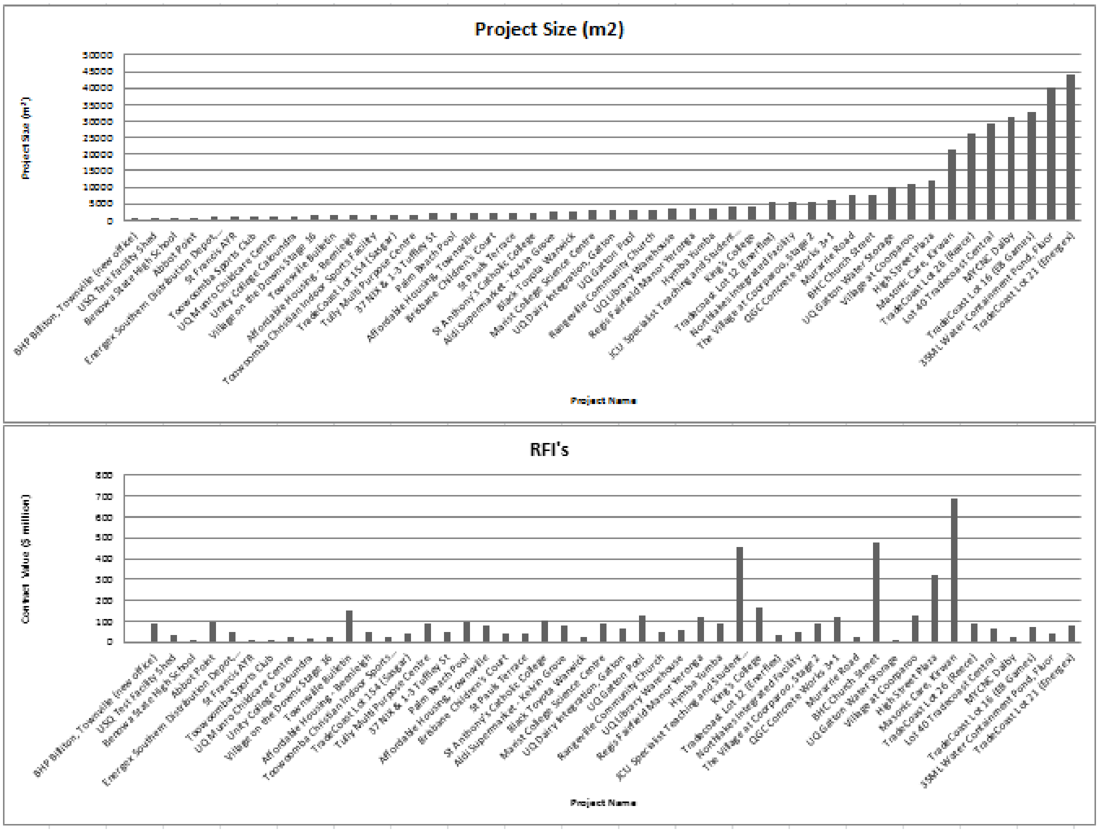


Figure 34 – Visual trend for Project Size verses number of RFIs

The statistical analysis below in table 9 and table 10 reveals that when taking just the;

- Lower quartile of data when ranked in Contract Value (average 1050 m^2), the average number of RFIs is just 46, a difference of -54%.
- Upper quartile of data when ranked in Contract Value (average 22,700 m^2), the average number of RFIs is 169, a difference of +70%.

Table 9 – Lower and Upper Quartile display of sample of data for Project Size

Lower Quartile of data		Upper Quartile of data	
Project Size (m2)	RFIs	Project Size (m2)	RFIs
360	88	7440	23
650	33	7440	481
728	7	10000	4
800	94	10862	130
1012	46	12000	324
1060	11	21344	687
1120	7	26325	89
1238	26	29000	67
1242	17	31257	27
1442	25	32820	71
1456	151	40000	40
1519	47	43900	81

Table 10 – Lower and Upper Quartile comparison for Project Size

	Average # of RFIs	Percentage change
All Data	99.23	
Lower Quartile of Data	46.00	-53.64
Upper Quartile of Data	168.67	69.98

3.4.3 Project Duration

The visual trend is shown below in figure 35, when re-producing the plot from section 3.3.3 and displaying directly below it the correlating number of RFIs for each project ranked in the same ascending order by Project Duration.

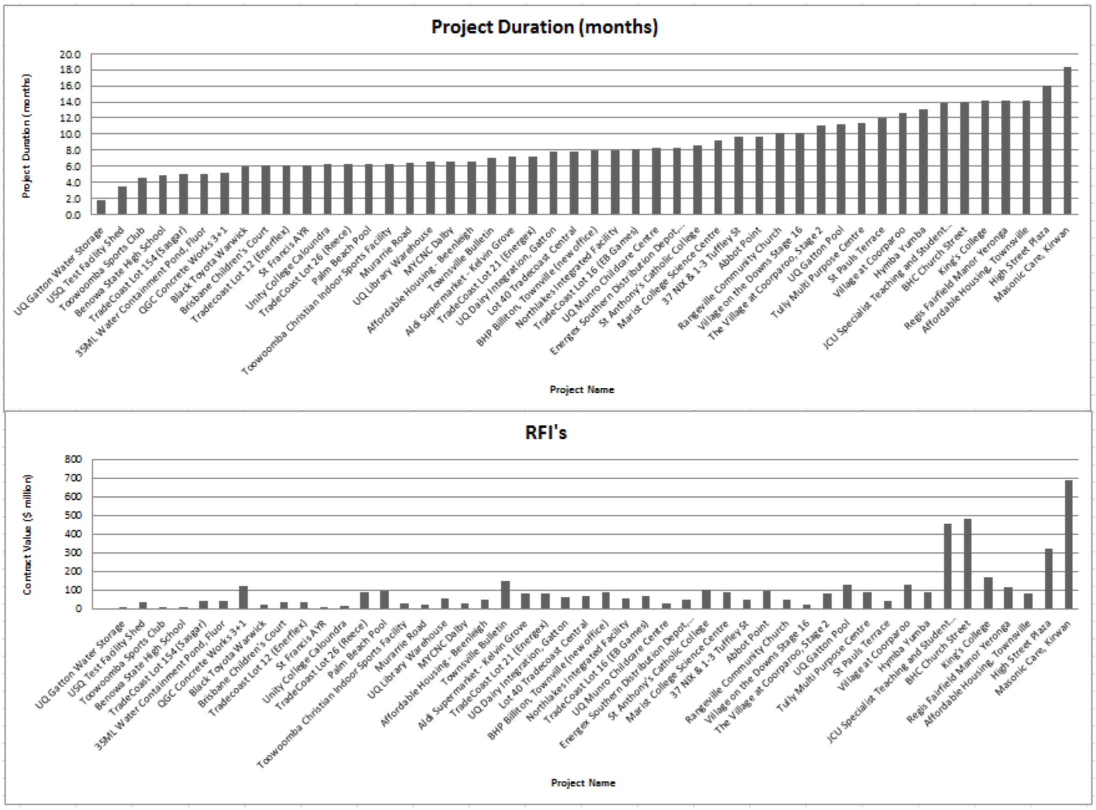


Figure 35 – Visual trend for Project Duration verses number of RFIs

The statistical analysis below in table 11 and table 12 reveals that when taking just the;

- Lower quartile of data when ranked in Contract Value (average 5 months), the average number of RFIs is just 32, a difference of -68%.
- Upper quartile of data when ranked in Contract Value (avg 13.75 months), the average number of RFIs is 233, a difference of +136%.

Table 11 – Lower and Upper Quartile display of sample of data for Project Duration

Lower Quartile of data		Upper Quartile of data	
Project Duration (months)	RFIs	Project Duration (months)	RFIs
1.8	4	11.2	127
3.4	33	11.4	89
4.5	7	12.1	45
4.9	7	12.6	130
5.0	41	13.1	92
5.1	40	13.8	455
5.1	123	14.1	481
6.0	25	14.1	166
6.0	38	14.1	119
6.1	37	14.2	84
6.1	11	16.0	324
6.2	17	18.375	687

Table 12 – Lower and Upper Quartile comparison for Project Duration

	Average # of RFIs	Percentage change
All Data	99.23	
Lower Quartile of Data	31.92	-67.84
Upper Quartile of Data	233.25	135.06

3.4.4 Project Complexity

The visual trend is shown below in figure 36, when re-producing the plot from section 3.3.4 and displaying directly below it the correlating number of RFIs for each project ranked in the same ascending order by Project Complexity.

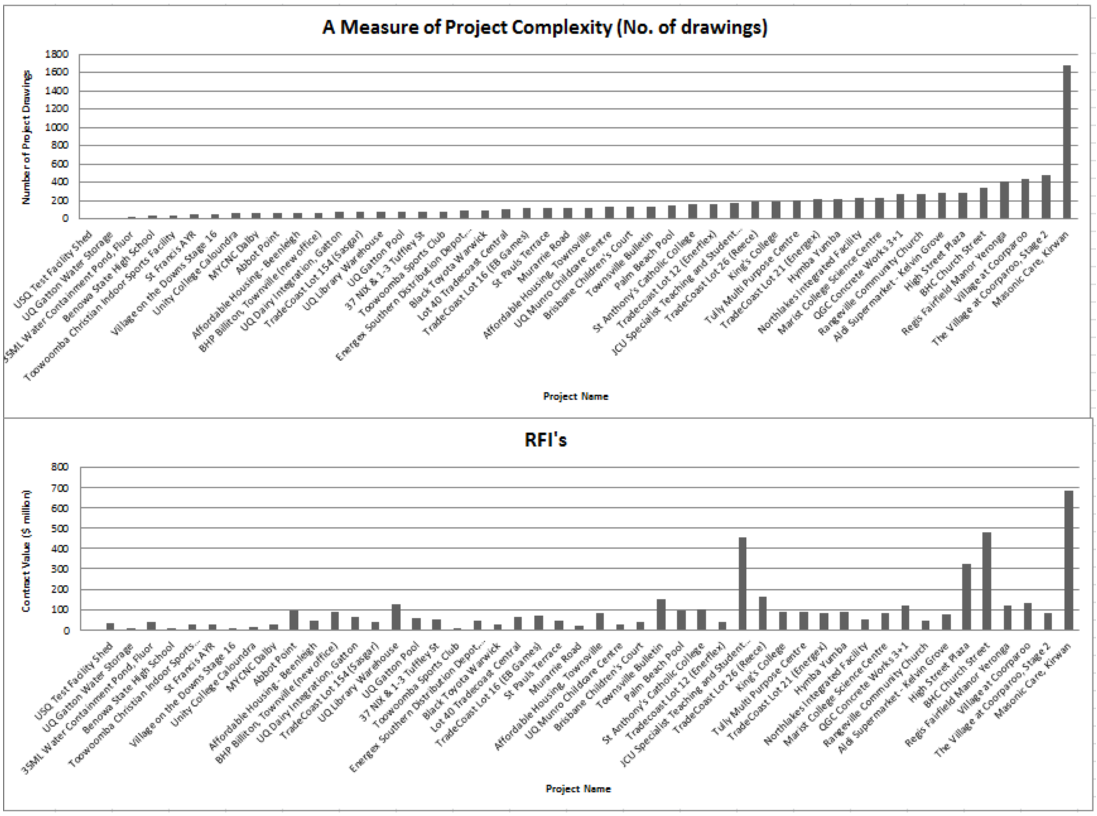


Figure 36 – Visual trend for Project Complexity verses number of RFIs

The statistical analysis below in table 13 and table 14 reveals that when taking just the;

- Lower quartile of data when ranked in Contract Value (avg 48 drawings), the average number of RFIs is just 35, a difference of -65%.
- Upper quartile of data when ranked in Contract Value (avg 429 drawings), the average number of RFIs is 192, a difference of +94%.

Table 13 – Lower and Upper Quartile display of sample of data for Project Complexity

Lower Quartile of data		Upper Quartile of data	
Project Complexity	RFIs	Project Complexity	RFIs
10	33	221	92
17	4	226	53
20	40	230	86
40	7	267	123
43	26	276	46
55	25	280	80
55	11	283	324
60	17	344	481
65	27	412	119
65	94	443	130
69	47	482	85
71	88	1684	687

Table 14 – Lower and Upper Quartile comparison for Project Complexity

	Average # of RFIs	Percentage change
All Data	99.23	
Lower Quartile of Data	34.92	-64.81
Upper Quartile of Data	192.17	93.66

3.4.5 Project Type

The statistical analysis below in figure 37 shows the average number of RFIs encountered for each project type, revealing that Residential/Retirement projects encounter the highest number of RFIs by 45% from the nearest rival which is education.

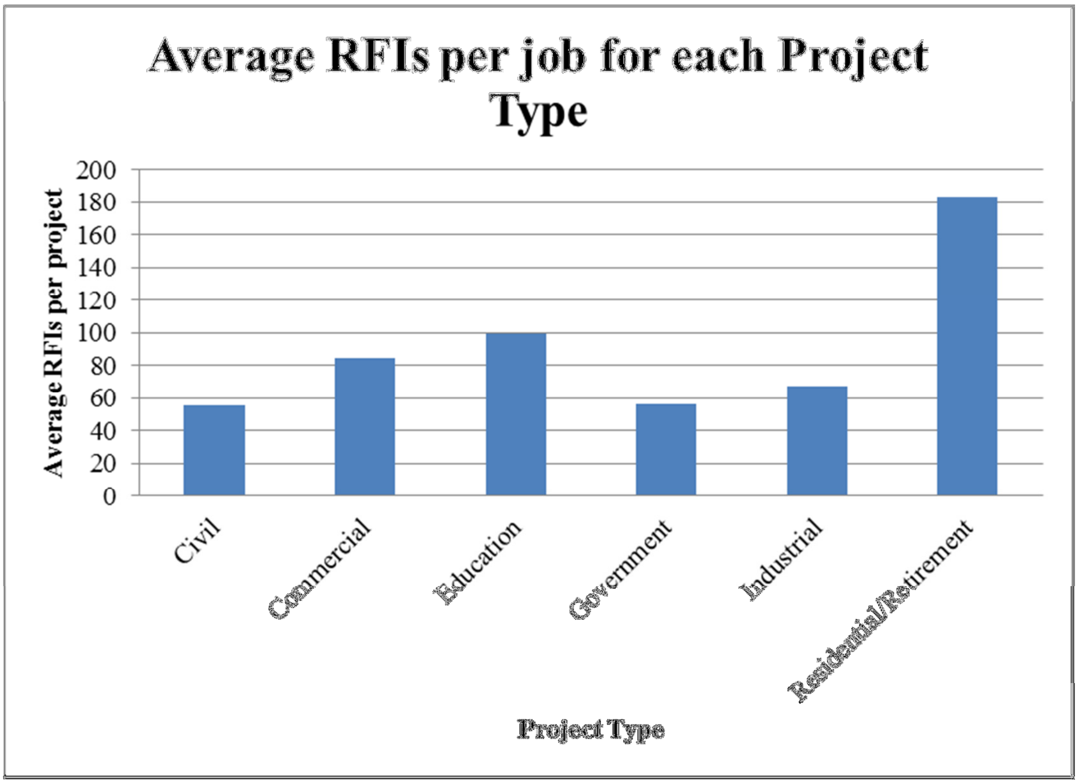


Figure 37 – Statistical Analysis for Average number of RFIs for each project type

3.5 Key Project Characteristics

As a result of the data manipulation in section 3.4, the key project characteristics were revealed that are most commonly evident on jobs that have had high numbers of RFIs.

The Upper Quartile percentage change is of the most interest to determine what the most influential project characteristic is. By far the most dominant indicators are projects that have high Contract Values, long Project Durations and that are Residential/Retirement in nature.

Table 15 below shows a summary of the Upper Quartile Deviation Percentages of each characteristic, of which the critical ones are in red font. It can be seen that the contract value and the project duration are considerably more dominant than project size and project complexity, while Residential/Retirement is stated as the most dominant project type.

Table 15 – Comparison of Upper Quartile Deviation percentages

Characteristic	Upper Quartile Deviation %
Contract Value	128
Project Size	70
Project Duration	135
Project Complexity	94
Project Type	Residential/Retirement

This information goes a long way as to reveal which types of projects would benefit mostly from strategies to reduce the number of RFIs. On average, RFI numbers are at their most severe when these characteristics are combined on any single project, and out of the sample of projects investigated, there are five occurrences of this (about 10% of projects).

In order to generate strategies to minimise the impact of RFIs, further information was collected from these 5 sample projects that feature high contract values, long project durations and are Residential/Retirement projects. The properties of these five projects are shown in table 16 below.

Table 16 – 5 projects with key characteristics for further analysis

Job Name	Contract Value ($ mil)	Project Type	Project Size (m2)	Project Duration (months)	Number of Drawings	Number of RFIs
BHC Church Street	15.5	Residential /Retirement	7440	14.1	344	481
Regis Fairfield Manor Yeronga	15.9	Residential /Retirement	3500	14.1	412	119
Village at Coorparoo	19.3	Residential /Retirement	10862	12.6	443	130
Village at Coorparoo, Stage 2	23.3	Residential /Retirement	5775	11.1	482	85
Masonic Care, Kirwan	34	Residential /Retirement	21344	18.375	1684	687

3.6 RFIs categorized by discipline

In order to gain useful information that can be utilised in strategies, each RFI in each of these jobs were categorized into their design discipline. This is to determine the discipline that is most commonly 'questioned' in RFIs, providing an insight into where the majority of RFIs stem from, and assisting in generating an effective strategy to reduce RFI numbers.

The RFIs were categorized into Architectural, Electrical, Hydraulic, Structural, Mechanical, Civil, Landscaping, Surveying, Miscellaneous (for pieces of equipment such as lifts, cranes and roller shutters) and Not Applicable (for RFIs that were not entitled to be categorized into any of the above, or perhaps where it should not have been an RFI). These are the most common disciplines and would often attract an entire set of drawings for each of these disciplines, either created by the single consultant, or multiple. Therefore the topic of the RFI is easy to distinguish between each of these disciplines and an accurate study can be achieved.

Appendix H contains the full set of data as recorded for each RFI on each project. The sub-totals were recorded using Microsoft Excel and are tabulated and graphically displayed in below tables 17 – 22 and figures 38 – 43, while the results of this secondary study are discussed in the ensuing chapter.

3.6.1 Averaged for All 5 Projects

Table 17 – Discipline Information averaged for all 5 projects

Range: All 5 Projects		
Disciplines:	Quantity of RFIs	%
A - Architechtural	696	46.3
E - Electrical	236	15.7
H - Hydraulic	208	13.8
S - Structural	153	10.2
M - Mechanical	62	4.1
C - Civil	38	2.5
MISC - (lifts, roller shutters, etc)	37	2.5
L - Landscaping	37	2.5
SURVEY - Surveying	17	1.1
N/A - not applicable to specific Discipline	14	0.9
D - Demolition	4	0.3
Total	*1502*	*100*

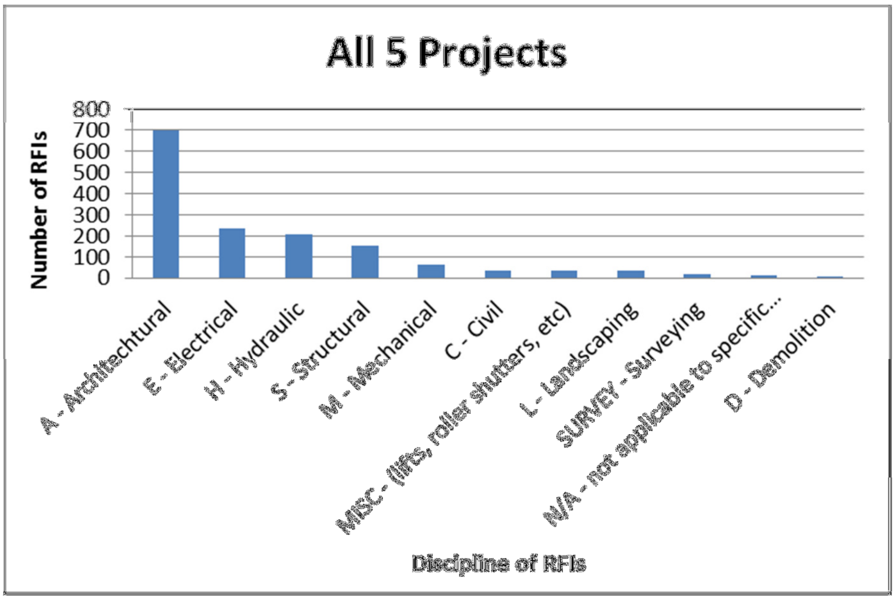


Figure 38 – Discipline Information graphically presented averaged for all 5 projects

In order to verify that the average spread of RFI disciplines of the five projects was consistent throughout each individual project, the same data is presented below, individually for each project. The distribution of RFI disciplines is relatively consistent from job to job which provides a level of comfort that the averages above are a true reflection of projects that are Residential/Retirement in nature.

3.6.2 BHC Church Street

Table 18 – Discipline Information for BHC Church Street

Range: BHC Church Street		
Disciplines:	Quantity of RFIs	%
A - Architechtural	191	39.7
E - Electrical	74	15.4
H - Hydraulic	83	17.3
S - Structural	64	13.3
M - Mechanical	16	3.3
C - Civil	12	2.5
MISC - (lifts, roller shutters, etc)	14	2.9
L - Landscaping	9	1.9
SURVEY - Surveying	12	2.5
N/A - not applicable to specific Discipline	4	0.8
D - Demolition	2	0.4
Total	*481*	*100*

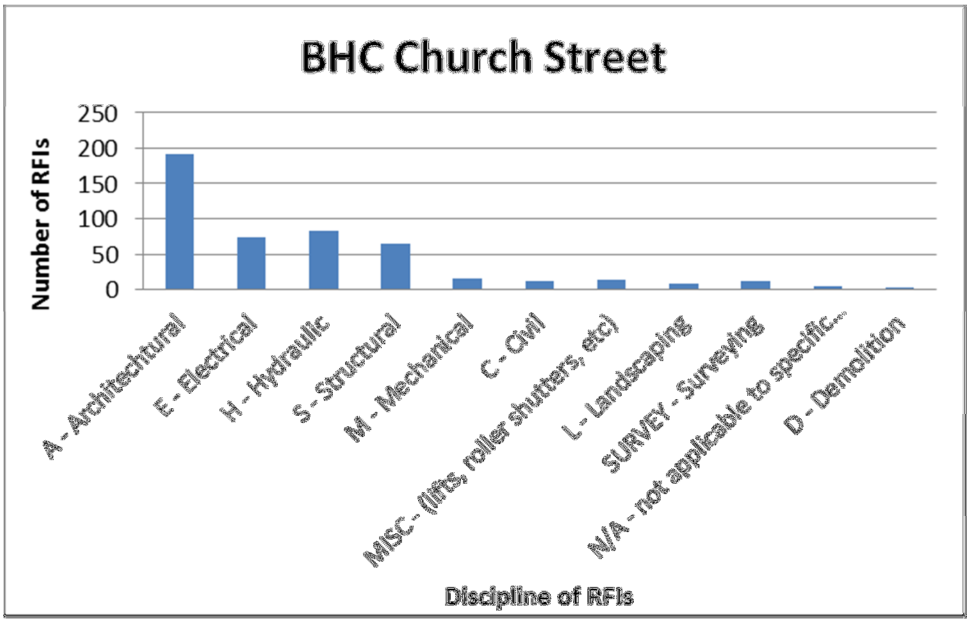


Figure 39 – Discipline Information for BHC Church Street

3.6.3 Regis Fairfield Manor Yaronga

Table 19 – Discipline Information for Regis Fairfield Manor Yaronga

Range: Regis Fairfield Manor Yaronga		
Disciplines:	Quantity of RFIs	%
A - Architechtural	74	62.2
E - Electrical	2	1.7
H - Hydraulic	13	10.9
S - Structural	14	11.8
M - Mechanical	7	5.9
C - Civil	1	0.8
MISC - (lifts, roller shutters, etc)	3	2.5
L - Landscaping	4	3.4
SURVEY - Surveying	0	0.0
N/A - not applicable to specific Discipline	1	0.8
D - Demolition	0	0
Total	*119*	*100*

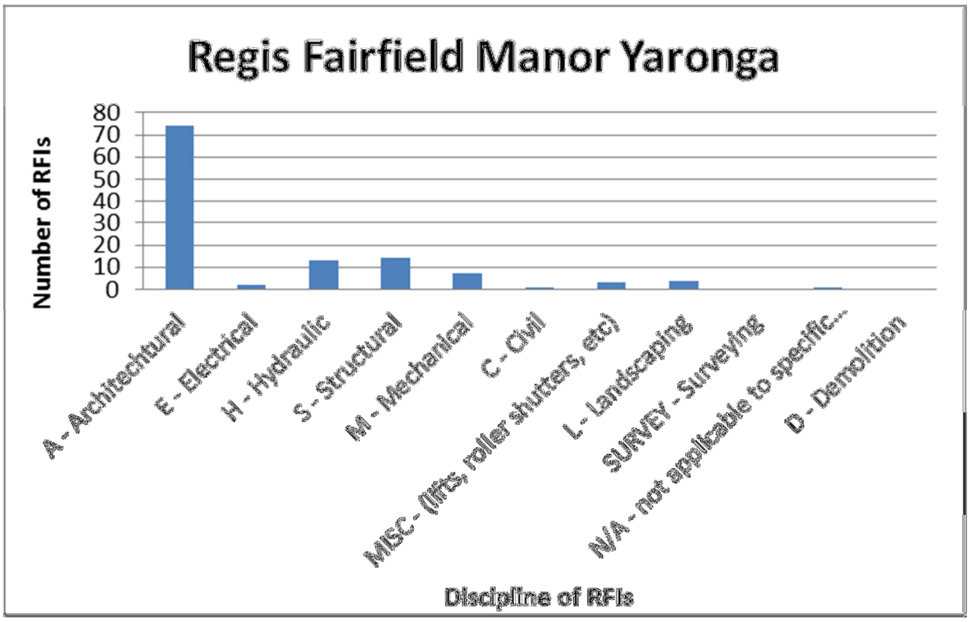


Figure 40 – Discipline Information for Regis Fairfield Manor Yaronga

3.6.4 Village at Coorparoo

Table 20 – Discipline Information for Village at Coorparoo

Range: Village at Coorparoo		
Disciplines:	Quantity of RFIs	%
A - Architechtural	63	48.5
E - Electrical	23	17.7
H - Hydraulic	9	6.9
S - Structural	11	8.5
M - Mechanical	4	3.1
C - Civil	4	3.1
MISC - (lifts, roller shutters, etc)	8	6.2
L - Landscaping	6	4.6
SURVEY - Surveying	0	0.0
N/A - not applicable to specific Discipline	1	0.8
D - Demolition	1	0.8
Total	*130*	*100*

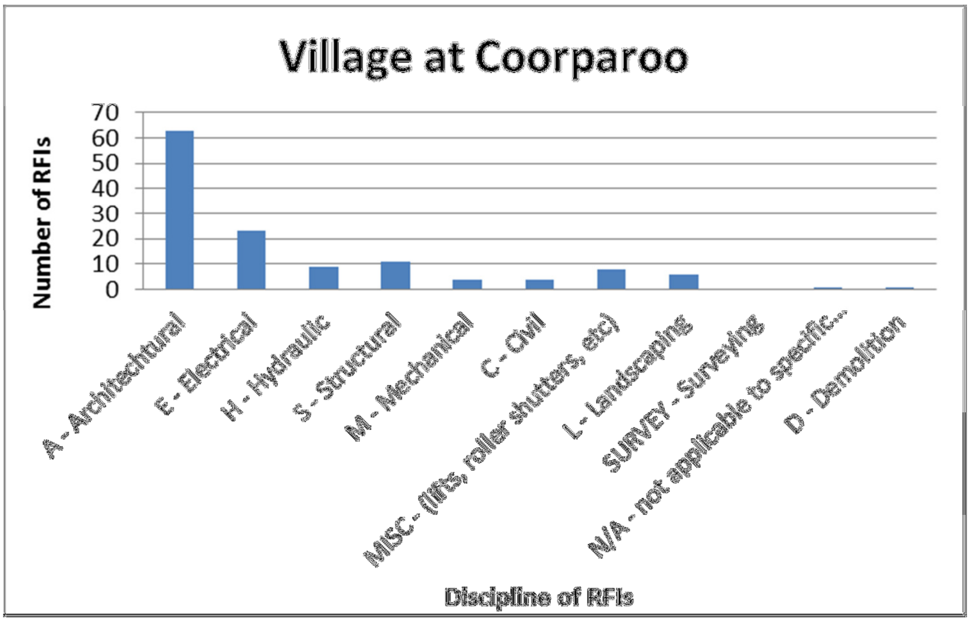


Figure 41 – Discipline Information for Village at Coorparoo

3.6.5 Village at Coorparoo, Stage 2

Table 21 – Discipline Information for Village at Coorparoo, stage 2

Range: Village at Coorparoo Stage 2		
Disciplines:	Quantity of RFIs	%
A - Architechtural	32	37.6
E - Electrical	15	17.6
H - Hydraulic	15	17.6
S - Structural	7	8.2
M - Mechanical	10	11.8
C - Civil	2	2.4
MISC - (lifts, roller shutters, etc)	1	1.2
L - Landscaping	2	2.4
SURVEY - Surveying	0	0.0
N/A - not applicable to specific Discipline	1	1.2
D - Demolition	0	0
Total	*85*	*100*

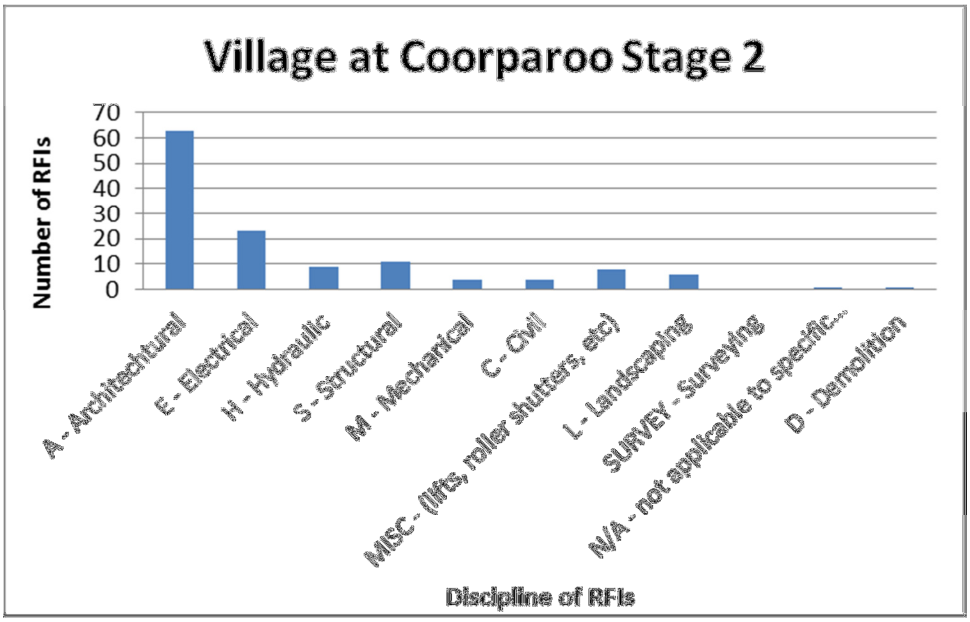


Figure 42 – Discipline Information for Village at Coorparoo, stage 2

3.6.6 Masonic Care, Kirwan

Table 22 – Discipline Information for Masonic Care, Kirwan

Range: Masonic Care, Kirwan		
Disciplines:	Quantity of RFIs	%
A - Architechtural	336	48.9
S - Structural	57	8.3
H - Hydraulic	88	12.8
E - Electrical	122	17.8
M - Mechanical	25	3.6
C - Civil	19	2.8
MISC - (lifts, roller shutters, etc)	11	1.6
L - Landscaping	16	2.3
SURVEY - Surveying	5	0.7
N/A - not applicable to specific Discipline	7	1.0
D - Demolition	1	0.1
Total	*687*	*100*

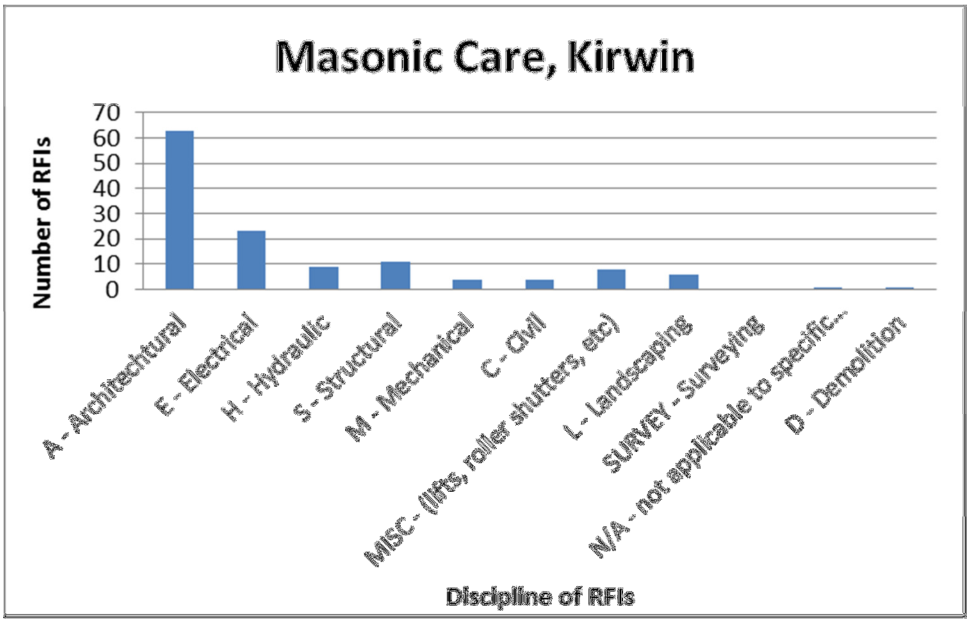


Figure 43 – Discipline Information for Masonic Care, Kirwan

A further study was conducted on the Masonic Care project to analyse RFI response times, refer to Appendix G. This analysis was conducted to validate the impacts that RFIs have on projects as per section 2.6. This additional case study does not reflect on the objectives of the dissertation and hence the results are not duplicated here.

CHAPTER 4 – RESULTS AND DISCUSSION

4.1Results

4.1.1 Key Project Characteristics

The purpose of investigating the sampled projects was to determine the type of projects that are attributed to having large amounts of RFIs, and hence a considerable amount of wasted time and costs associated. While this study did not set out to prevent all RFIs on all future jobs, a need was identified to reduce the impact that RFIs have on certain jobs. Not all projects are hit by significant additional time and costs as a result of RFIs, however it is safe to say that the chances of losing time and costs increase proportionally with the number of RFIs on a job. The associated lost time and costs are attributed to the fact that RFI documents themselves are a laborious task to generate and track, as well as the impact that these pending decisions have on procurement of materials and disruption to the flow of construction on-site.

Being able to reduce the impact of these facets comes down to firstly being able to predict and/or identify the projects that are most affected by RFIs, and to do this, the case-study was conducted on a large sample of 48 actual projects. Each and every project can be attributed to a set of 'project characteristics' and it is these project characteristics that were analysed statistically for each job by comparing the RFI numbers of the projects that they belong to.

As outlined in section 3.5, the key project characteristics that were most commonly evident on jobs that have had high numbers of RFIs have been identified, and the results have been duplicated below in table 23.

These characteristics are projects that;

- Have high contract values,
- Have long project durations, and are
- Residential/Retirement in project type

Table 23 – 5 projects with key characteristics for further analysis

Job Name	Contract Value ($ mil)	Project Type	Project Size (m2)	Project Duration (months)	Number of Drawings	Number of RFIs
BHC Church Street	15.5	Residential /Retirement	7440	14.1	344	481
Regis Fairfield Manor Yeronga	15.9	Residential /Retirement	3500	14.1	412	119
Village at Coorparoo	19.3	Residential /Retirement	10862	12.6	443	130
Village at Coorparoo, Stage 2	23.3	Residential /Retirement	5775	11.1	482	85
Masonic Care, Kirwan	34	Residential /Retirement	21344	18.375	1684	687

Considering just these five 'high risk' projects alone, their RFIs are averaged at just over 300, which means roughly 300% more impact from RFIs than a 'typical job'.

Further deliberation could be applied considering the Village at Coorparoo Stage two only received 85 RFIs, and this was due to the fact that the build is very much similar to its stage ones predecessor in every facet, and therefore fewer un-known elements. Excluding this stage two project, the average RFIs jump to over 350, which amounts to 350% more impact from RFIs than a standard typical project.

It is therefore evident that efforts must be made to limit the impact on these types of projects that have proved to have been affected substantially more than the average project, just from the submission of additional RFIs.

From breaking down these five projects and analysing their characteristic properties, a precedence can be formed that will ensure future projects that are won at tender, can be easily assessed for risk of severe RFI impact, as per below flowchart (figure 44);

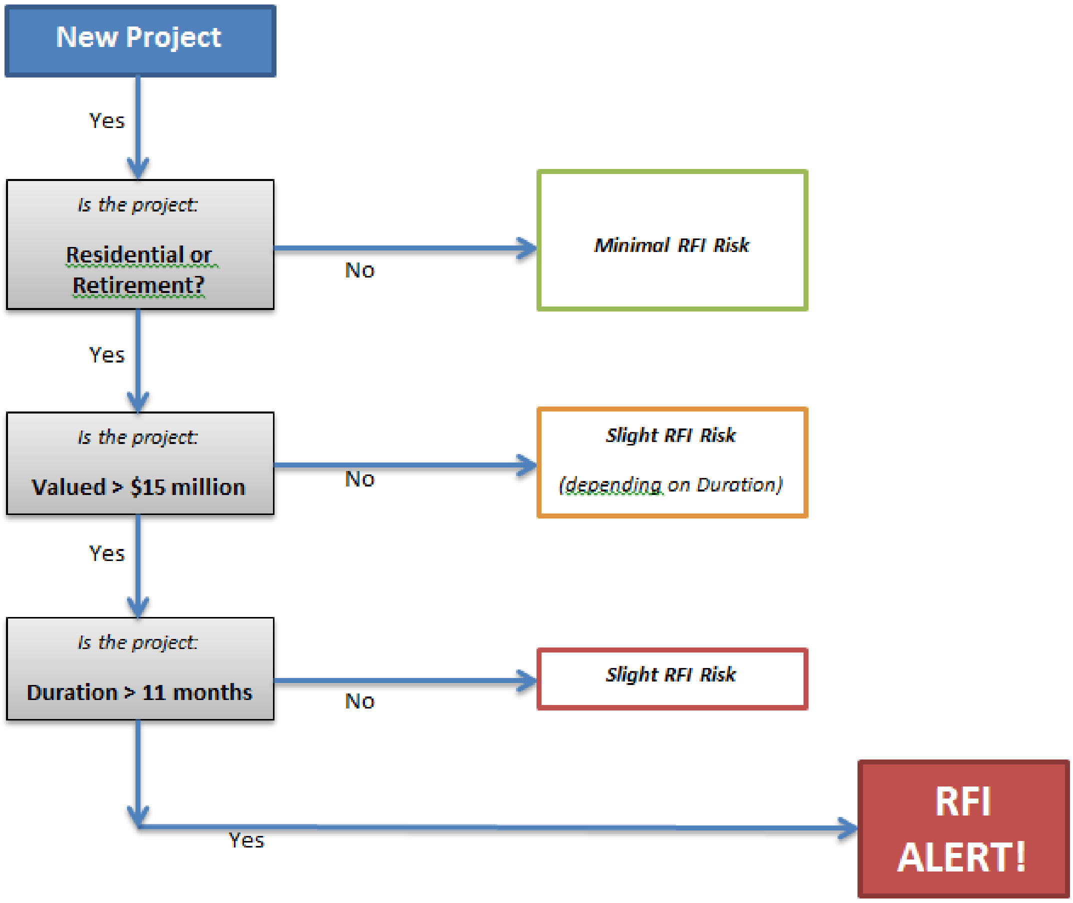


Figure 44 – Flow chart to assess new projects for risk of excessive RFI impact

It is proposed to embed these rules into McNab Constructions standard '*Project Start up Form 05.55*'. This form is an excel sheet and is completed by the Project Manager prior to any new project that is due to commence. As-is, this form includes these key pieces of information to be inputted, and thus it is proposed that a new cell be created with a formulated 'if' statement, that checks for compatibility of these rules to alert the Project Manager of the risk of excessive RFI impact.

For a project that is going to be potentially exposed to high amounts of RFI impact, section 4.1.2 below displays some findings from the second part of investigations.

4.1.2 Key RFI Discipline

Being able to identify the projects most at risk to RFI impact is extremely important information; however without knowing how to reduce this impact, the study would be of little practical use.

Taking each of the five projects that were identified in above section 4.1.1, each RFI was categorized into the discipline that it relates to and recorded. This identified which discipline/s attracted the largest influx of RFIs and a strategy can then be formulated accordingly.

The disciplines that were used to categorize the RFIs are listed below, and these were selected due to the fact that on most jobs, a set of each of these drawings are present and hence RFIs can be easily categorized accordingly.

- Architectural
- Electrical
- Hydraulic
- Structural
- Mechanical
- Civil
- Landscaping
- Surveying
- Demolition
- Misc. (for specialised pieces equipment, Lifts, Cranes, Roller Shutters)
- N/A (where RFIs were not entitled to be categorized into any of the above, or perhaps where it should not have been an RFI at all).

As quantified in section 3.6, table 17 and figure 38 are duplicated here below for ease of reference.

Table 24 – Discipline Information averaged for all 5 projects

Range: All 5 Projects		
Disciplines:	Quantity of RFIs	%
A - Architechtural	696	46.3
E - Electrical	236	15.7
H - Hydraulic	208	13.8
S - Structural	153	10.2
M - Mechanical	62	4.1
C - Civil	38	2.5
MISC - (lifts, roller shutters, etc)	37	2.5
L - Landscaping	37	2.5
SURVEY - Surveying	17	1.1
N/A - not applicable to specific Discipline	14	0.9
D - Demolition	4	0.3
Total	*1502*	*100*

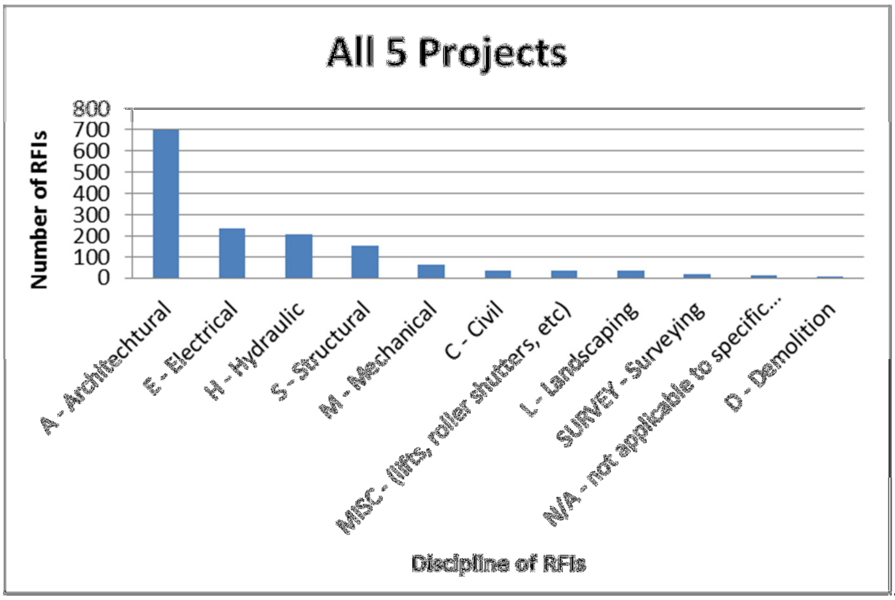


Figure 45 – Discipline Information graphically presented averaged for all 5 projects

This shows a resounding result that Architectural issues are most frequently RFI'd, and therefore can be taken into consideration accordingly when generating a strategy to minimise the impact of RFIs on future projects.

4.2Circumstantial Factors for High RFI Impact

Other than the simple facts that certain project characteristics are more conducive to large numbers of RFIs than others, there may be circumstantial reasons as to why the RFI impact may have been so large for certain projects and not others that display similar characteristics. These circumstantial factors cannot be ignored, and therefore it is also important to consider them when deliberating over strategies to reduce RFI impact for future projects.

The link between certain circumstantial factors and the high risk project characteristics may or may not be evident however the investigation of this falls outside of this projects scope. This section ties hand-in-hand with '*Section 2.5 Root Causes of RFIs*', however as opposed to the root causes of RFIs, this section addressed the Root Causes for *additional RFIs* and therefore *additional RFI impact*.

4.2.1 Relationships

Building strong relationships between the contractor and the client or client's representative can be an effective way in minimizing the need to issue certain RFIs. If there is a level of trust built between the parties, it is more likely that small issues can be resolved verbally on by informal written communication such as email, which is ideal as the delays are minimal. This relationship can form around the basis of experience and performance ability of the respective project personnel where fundamental trust can be gained from a proven track record, and hence the paper 'throughput' can be minimal. Where a relationship is not ideal, it is likely for *all* clarifications to be required to follow the formal path via an RFI and this can lead to frustration and additional time and cost ramifications.

The relationship between the consultants and the client can also be indicative of the strength of the design documentation, and can factor in how timely RFI responses are. On the instances where there is disconnect between the clients representative and the consultant teams, expectations of the client can differ to the contractors and the consultants understanding. The client's representative may instil a certain amount of 'fear' into the contractor if the end product is not as per design documentation, and thus causes an influx of RFIs from the contractor to ensure the correct action is taken for each and every construction element.

Project Superintendents can differ in the way they deliver their services as well, for instances when they take a hierarchal stance, it can take away from the collaborative/collective efforts that work so well in construction.

4.2.2 Performance of Consultants

How well the consultants have performed can dictate dramatically the impact of RFIs for the contractor. The performance is measured not just via the thoroughness of design documents, it can relate to how often and how timely their site attendance was, how quick they respond to RFIs and their strength of communication.

For consultants trying to run a business there is a balance between completing a design to its full extent with coverage of every element of construction detail, while trying to cut down on expenses such as spending time and money in attempt to remain under budget. This can result in an 'under designed' project at the expense of saving some money to be more profitable. This is a commercial decision that all consultants have to make and can influence how much impact the contractors have as a result. Consultants could waste considerable time and money detailing certain elements of the design that won't even be used by the contractor or subcontractors, and thus for the consultant it is safer for them to 'under design' and let the contractor raise the issues that need to be addressed. This situation is obviously not ideal for contractors and can impact dramatically on RFI numbers.

The extent of how complete the design is can impact works throughout the construction program if there are changes being made or if the design is still being finalised while construction has commenced.

A team of various multi-disciplinary consultants working on the same project can become unstuck if there is no 'lead consultant' (usually the Architect), and the coordination between services and disciplines becomes an issue through lack of detail. The coordination of services or lack thereof throughout the design phase, is the cause for many RFIs in the construction industry. This is exaggerated in retirement/residential type construction due to the presence larger than average amounts of services within the building/s.

4.2.3 Construction Difficulty and Contractor Experience

A contractor's lack of experience for a type of project can mean that RFIs are needed to be raised that perhaps a more experienced team could have dealt with on the fly. It is important to identify the ability and the construction experience amongst the make-up of a project team from the on-set, especially if the type of construction is new to the contracting company. If similar jobs have been completed in the past, a transfer of 'learning's' from one team to the next is important if the same project team cannot be sustained.

4.3Recommendations for Strategy to Limit Impact

Utilising the above information the following strategies are recommended to reduce the impact of RFIs on future projects that are Residential/Retirement, over $15 million and are over 11 months in duration;

- Determine if the new project falls under the high risk for RFI impact category utilising the check-cell on the *Project Start Up Form 05.55* (as per section 4.1.1), and if not, assess how far away it is from being high risk.

- As early as possible prior to the start of construction, conduct a full review of the project documents with the project team present (office and site based personnel). This is to identify a number of items as listed below. With the knowledge that the Architectural discipline is most affected by RFI impact, the onus shall be accordingly focused to those documents.

  - Identify what stage the design is at in terms of being a percentage complete (the lower the completeness, the larger the element of unknown is and a higher potential for RFIs is present).
  - Look for conflicting or erroneous elements of the plans and specifications.
  - Identify as many constructability issues as possible.
  - Identify cost-saving solutions where alternative construction methods or material proposals are viable.

These issues must be raised with the client as soon as possible, preferably prior to letting of works to sub-contractors, as it is most efficient to have design changes out of the way prior to the finalisation of subcontract negotiations. This obviously depends on how much time is available to maintain program and potentially start on site.

Once the team of sub-contractors have been selected, their expertise must be capitalized on for further review into their trade in order to identify anything that would warrant an RFI. Having these issues on the table early may rid the need to issue an RFI at a later stage where cost implications are much higher. It could be valuable to have a meeting where all subcontractor attendance is compulsory, for coordination issues to be resolved together through brainstorming. This utilises the concept of lean construction as outlined in previous studies (Tilley 1997).

It is important to capture knowledge stowed away in peoples mind and therefore a ‘download’ of information from project teams that have been involved on the highlighted five jobs, would be useful. Highlighting the major issues and experiences would be beneficial for project teams to learn and take on board.

Building a relationship of trust with the client will go a long way to reduce the reliance of sending RFIs for every little issue that may or may not need to be answered via an RFI. Proving competence straight up prior to construction may ease the client's expectation and therefore they may be willing to let a few issues go that would normally be required to go in an RFI. It is inevitable that RFIs are required on any job, but every measure possible to reduce their numbers goes a long way to reduce over-all impact on time and cost.

For the RFIs that are unavoidable, they must be drafted with a high level of nous in order to maximise their efficiency. Properly utilising the form is important as to keep it technical and related to the design drawings or constructability of the project. Utilising sketches, figures, marked up drawings/specifications, calculations, product/sheets and following a well-structured layout with concise engineering language, is important. Asking the question that needs to be asked in as few words as possible without missing any key detail, is an ability that is hard to master but is fundamental in drafting an effective RFI. If possible, the contractor should provide their desired resolution on the RFI as to make the consultants life easier and hopefully speed up the turn-around time of the RFI while ensuring the response is as desired. This proposed solution must be justified accordingly and fairly.

Last of all, it is critical to ensure the impact of RFIs for these types of projects is quantifiable and as such can be incorporated into estimating figures, so that the contractor does not take a surprise hit on their budget when RFI numbers escalate. By knowing which types of projects are prone to this additional RFI cost, tendering to consider these additional costs is important.

CHAPTER 5 – CONCLUSIONS

The impact that RFIs have on the industry in today's era of construction was thoroughly investigated and conclusions were drawn accordingly. Recommendations for the implementation of strategies were made that will see future projects undergo lesser amounts of adverse impact as a result of the RFI process.

5.1 Achievements

This research project was able to be completed in an efficient manner by closely following the methodologies as outlined in section three, and therefore the project goals and objectives as outlined in section one were met.

A large contributing factor that aided in the attainment of the goals was the quality and quantity of data, even after the parameters meant narrowing down the spread of projects available. The parameters themselves that were set aided in the practicality of the results, in order to apply the conclusions to future projects that display similar parameters. Upon investigation, the projects studied as part of the case study were consistent in both the archiving of project data and the actual trends found within the data. This can be put down to the processes and procedures that McNab Constructions follow from job to job and from project team to project team over the past five years that were sampled, that make retrieving data seamless and accurate. A great success was also being able to pin point exact project characteristics that distinctly showed significant influence over the number of RFIs than the others. This gave confidence in the results and meant that discretion was not required in order to present the 'high risk characteristics'.

The impact of RFIs on past construction projects was able to be successfully linked to key project attributes and this information was then used to investigate the root causes of RFIs on these particular projects. From here the characteristics of the RFIs themselves were revealed to identify the discipline that causes the largest impact, which was found to be the Architectural design discipline. Even though a circumstantial factor presented that indicated that Residential/Retirement projects succumb to a higher degree of services and service coordination, Architectural issues were still predominantly RFI'd more often than even all services (electrical, hydraulic and mechanical) combined. 46% of RFIs were Architectural and 34% were services.

The quality of these results gave the impact-reducing strategies a justifiable area to target in order to reap the most reward, which is a reduction in the additional time and costs as a result of RFI impact. The recommended strategies were based off of the findings of the case-study and also took into consideration the circumstantial factors behind why certain projects are excessively impacted by RFIs more-so than others. Recommendations were also made as to how RFIs can be formulated more effectively to gain the most out of them, and this in itself is a way to reduce RFI impact.

All of the objectives outlined were able to be accomplished in a practical manner.

5.2 Limitations

The Limitations experienced did not inhibit the objectives from being achieved as stated above, however there were some short fallings none-the-less that are identified below.

The value of the impact that individual RFIs have on projects had been investigated in previous studies and this was utilised as the basis of this dissertation. The values of the overall impact for the projects in this case-study were not quantified, as the scope that was able to be achieved was limited by time and resources available. The generalisation was therefore made that the impact on a project as a result of RFIs was proportional to the number of RFIs on the job. This extends to assume that being able to reduce the number of RFIs and making recommendations as to better generate RFIs, will reduce the value of the given impact. The limitation is therefore that this study has a level of uncertainty in terms of the quantified benefit, until it can be put into practice and data can be compared in a 'before and after' scenario. It is unknown and relatively unquantifiable at this stage, how many RFIs can be avoided by implementing said the recommended strategies, and the related dollar value saving as a result. This dissertation was carried out to more-so to create the awareness relating to RFI impact and investigate its nature, and this has been achieved.

Another limitation was the fact that only construct only project data was possible to utilise due to the lack of D&C projects available. Originally the objectives did not limit themselves to construct only projects; however this was adapted according to the data available. This limitation does not however adversely affect the results that were obtained, as a comprehensive case-study was still able to be carried out on construct only projects. This is still greatly beneficial to McNab Constructions as they adopt mostly traditional construct only projects.

Another limitation that was also experienced came as a result of limited published literature available for the Request For Information process itself. This did not inhibit the ability to create the methodology though due to the simplicity of the principles and literature for the RFI itself, and having exposure to the construction industry and dealing with RFIs on a day to day basis which helped aid the direction of the objectives.

5.3 Further Work

The possibilities for further work are endless relating to RFIs in general, and a couple are identified below;

- Investigate the relationship between the number of RFIs and;
  - Site Instructions and Variations
  - Drawings Issued (Original verses Final)
  - Contract Value (Original verses Final adjusted)
- Project Delays (Quantifying firstly the amount of man-hours lost just drafting and tracking the RFIs taking into consideration RFI delayed response times, and secondly the total days lost due to construction delays on-site as a result of the pending design decisions)

The following opportunities for further work tie in closely with this particular dissertation and could have been incorporated if further time and resources existed;

- Financial analysis into the reduction of impact from implementing these strategies. Is this quantifiable?
- Is there a link between the circumstantial factors stated in section 4.2 and the high risk project characteristics?
- Investigating if there was a relationship between project RFIs and the consulting firms that were appointed for each discipline of design. This would indicate if there are particular firms that are prone to more RFIs if their strategy is perhaps orientated around reducing costs rather than achieving a thorough design.
- Utilising a database of sample project RFI registers from other companies other than McNab Constructions. This determines if McNab's experiences represent the industry norm. These other companies could be different geographic locations in Australia, competing in different markets and could be top, middle or bottom tier builders.
- Look into RFI impact on D&C jobs (as per above point) and the relationship of RFIs to the client verses RFIs to consultants.

REFERENCES

American Institute of Architects 2006, *The RFI's Role in the Construction Process*, American Institute of Architects, Washington DC, viewed 8 May 2013, <http://www.aia.org/aiaucmp/groups/ek_members/documents/pdf/aiap016381.pdf>.

Australian Construction Resources 2013, *Australian Construction Industry: Past, Present, Future,* Australian Construction Resources, Victoria, viewed 15 May 2013, <http://constructionsa.com.au/australian-construction-industry-past-present-future/>.

(CEMDC) Construction Engineering Management Document Control 2013, *TQ – Technical Query*, Construction Engineering Management Document Control, Glasgow, UK, viewed 28 April 2013 <http://www.wp.tdocplus.co.uk/index.php/meaning-of-terms/92-tq-technical-query>.

Clawson Architects LLC 2011, *Understanding the Client – Architect – Contractor* Relationship, Clawson Architects LLC, New Jersey, viewed 20 September 2013, <http://clawsonarchitects.blogspot.com.au/2011/04/understanding-client-architect.html>.

Construction Industry Institute (CII) 1986, *Constructability Task Force,* Construction Industry Institute, Austin, Texas.

Defranco 2010, *The Project Life Cycle Overview,* Defranco, Brazil, viewed September 28, 2013, <www.defranco.com.br/mario/doku.php?id=2.1_the_project_life_cycle_overview>.

Dion Seminara Architecture 2011, *Architects and Other Parties* in the Construction Process, Dion Seminara Architecture, Queensland, viewed 15 October 2013, <http://www.dsarchitecture.com.au/why-hire-an-architect.html>.

Dombkins 2012, *Dombkins WHOW Model,* Tuấn Long, viewed 3 July 2013, <http://www.scribd.com/doc/92659179/Dombkins-WHOW-Model>.

Emmitt, S & Gorse, C 2013, *Communicating in Construction Teams,* Taylor and Francis, New York, NY

Fewings, P 2005, *Construction Project Management: An Integrated Approach*, Taylor and Francis, New York, NY.

Fluor Australia 2013, *Request For Information (RFI) Form 000.430.F0172 (revision 6 dated 6 March, 2013),* Fluor Australia, Brisbane, QLD.

Halpin, D & Riggs, L 1992, *Planning and analysis of construction operations,* John Wiley and Sons, New York, N.Y

Hanna, A, Tadt, E & Whited, G 2012, *Request for Information: Benchmarks and Metrics for Major Highway Projects,* J. Constr. Eng. Manage., 138(12), 1347–1352

Jergaes, G & Van der Put, J 2001, *Benefits of Constructability on Construction Projects,* Journal of Construction Engineering and Management, Issue July/August 2001, University of Toronto, Toronto, viewed 4 July 2013, <http://www.civ.utoronto.ca/sect/coneng/tamer/Courses/CIV1278/REF/benefits.pdf>

Korda Mentha 2012, *Construction Part 1 – Industry Overview,* Publication No.12-03, Korda Mentha, Brisbane, Queensland, viewed 5 May 2013, <http://www.kordamentha.com/docs/publications/12-03_construction_part-1-Industry-overview.pdf?Status=Master/>.

Leong, M & Tilley, P 1998, *Wasted Effort – To measure or not to measure: That is the question*, School of Engineering, Physics & Mathematics, University of Dundee: UK

McMullan Bros 2013, *Electronic Construction Law Journal - The Superintendent,* McMullan Bros, viewed 13 October 2013, <http://www.mcmullan.net/eclj/superin.html>.

Mohamed, S, Tilley, P & Tucker, S 1998, *Quantifying the time and cost associated with the request for information (RF) process in construction*, Griffiths University, QLD, Australia.

Queensland 2013, state map, Google maps, Australia, viewed 14 October 2013, <https://maps.google.com.au/maps/ms?ie=UTF8&t=m&oe=UTF8&msa=0&msid=216212657668758608552.0004c05c2dc5a4431be10>.

Queensland Government 2013, *4.5 Innovation and the use of Technology in Construction*, Queensland Government, Queensland, viewed 23 August 2013, <http://www.justice.qld.gov.au/fair-and-safe-work/industrial-relations/codes-of-practice-and-guidelines/queensland-code-of-practice-for-the-building-and-construction-industry/4-continuous-improvement-and-best-practice/4.5-innovation-and-the-use-of-technology-in-construction>.

Ross, A & Williams, P 2012, *Financial Management in Construction Contracting,* Wiley-Blackwell, West-Sussex, UK

Singh, H 2009, *Construction project Management*, Global Media, Chandigarh, India.

Tilley, P 1997, *Causes, Effects and Indicators of Design and Documentation Deficiency*, CSIRO Building, Construction and Engineering, Australia

Tilley, P, McFallan, S & Sinclair, R 2001, *Improving Design and Documentation Quality*, CSIRO Building, Construction and Engineering, Australia

Tilley, P, McFallan, S & Tucker, S 1999, *Design and documentation quality and its impact on the construction process*, Commonwealth Scientific and Industrial Research Organisation, Brisbane, Australia.

APPENDICES

APPENDIX A – PROJECT SPECIFICATION

University of Southern Queensland
FACULTY OF ENGINEERING AND SURVEYING

ENG 4111/4112 Research Project
PROJECT SPECIFICATION

FOR:	Robert Dinsmore
TOPIC:	INVESTIGATING THE IMPACT OF THE REQUEST FOR INFORMATION PROCESS IN CONSTRUCTION
SUPERVISOR:	Paul Tilley
ENROLEMENT:	ENG 4111 – S1, ONC, 2013 ENG 4112 – S2, ONC, 2013
PROJECT AIM:	To investigate the efficiency of construction projects given the impact of additional time and costs that accrue from dealing with RFIs as a result of design and documentation deficiencies.
SPONSORSHIP:	University of Southern Queensland
PROGRAMME:	Issue B - October 2013

1. Identify what the RFI process is, present literature on the relevant elements of the construction industry and explain how they affect the RFI process.
2. Identify the factors that influence the number of RFIs on a project, the root causes of RFIs and outline the related impact that RFIs have on projects.
3. Set parameters in order to select a sample of projects to use for case-study analysis and extract the relevant information accordingly.
4. Present the data obtained and analysis, to reveal key project characteristics that are most commonly evident on projects that have had high numbers of RFIs. With this knowledge, it would be possible to identify future projects that are likely to succumb to impacts of excessive RFIs, according to their particular characteristics.
5. Conduct further analysis on the RFIs for each of the sample projects that demonstrate a combination of 'high risk' characteristics and identify the discipline of design that contributes to the largest number of RFIs.
6. Using this specific information, recommend strategies to minimise the impact of RFIs for future 'high risk' projects. These should target both trying to reduce the number of RFIs required, and trying to make the RFI generation process as efficient as possible.

APPENDIX B – RFI EXAMPLE 1

A contractor would use an RFI if they need technical clarification relating to design documentation, drawings or specification

mcnab
relationship builders

REQUEST FOR INFORMATION

Date of Issue: 26/10/2011 **Response Required By:** 31/10/2011 **RFI # 231**

Project: Masonic Care Queensland - Townsville **Job #** 10072

Issued to:	Peter Boyce, Matt Stewart, Joel Ridings	**cc:**	Beacon - Greg McDonald
Company:	BMA	**cc:**	MCQ - John Byrne
Fax No:	via email	**cc:**	
# of Pages:	1 (incl this one)	**cc:**	

RFI Title: East Apartments - WC1 confirmation of specification **Bld: EA**

Description:

In accordance with clause B1.1 we have discovered a discrepancy or ommission in the contract documents as follows:

Refer to East Apartments Fittings and Fixtures schedule.
Please confirm that Pan/WC1 (Pressalit Dania A/Flap with Nordic Hinge)

- is to be WHITE in colour
- A/Flap should read D/FLAP (Meaning Double Flap)

We request that you provide your written instruction on how you wish to resolve this discrepany/ommission.

Issued by: Grace Wuth

Subcontractor: HPS (QLD) Pty Ltd **Ref #**

APPENDIX C – RFI EXAMPLE 2

An RFI is also able to be used for highlighting constructability issues that are not able to be foreseen when the consultants are designing the project prior to construction

mcnab
relationship builders

REQUEST FOR INFORMATION

Date of Issue: 18/10/2011	**Response Required By:** 20/10/2011	**RFI # 207**

Project: Masonic Care Queensland - Townsville	**Job #** 10072

Issued to: Peter Boyce, Matt Stewart, Joel Ridings	**cc:** Beacon - Greg McDonald
Company: BMA	**cc:** MCQ - John Byrne
Fax No: via email	**cc:**
# of Pages: 2 (incl this one)	**cc:**

RFI Title: Ceiling height amendments to accomodate mechanical	**Bld: RACF**

Description:

In accordance with clause B1.1 we have discovered a discrepancy or ommission in the contract documents as follows:

Refering to the attached marked up plan the area highlighted orange and marked with a '1' we request this section of ceiling be lowered 50mm to accommodate the mechanical ductwork. The other area highlighted orange and marked '2' we would request this section of ceiling be carried through at 2550 until the red line where we propose the bulkhead to be located.

We request that you provide your written instruction on how you wish to resolve this discrepany/ommission.

Issued by:

Subcontractor: **Ref #**

APPENDIX D – RFI EXAMPLE 3

Another reason to use an RFI would be to propose alternative construction solutions that may differ from the design and specification

\

REQUEST FOR INFORMATION

Date of Issue: 3/11/2011	**Response Required By:** 5/11/2011	**RFI # 255**

Project: Masonic Care Queensland - Townsville	**Job #** 10072

Issued to: Peter Boyce, Matt Stewart, Joel Ridings	**cc:** Beacon - Greg McDonald
Company: BMA	**cc:** MCQ - John Byrne
Fax No: via email	**cc:**
# of Pages: 3 (incl this one)	**cc:**

RFI Title: RACF - Alternative Insulation	**Bld: RACF**

Description:

In accordance with clause B1.1 we have discovered a discrepancy or ommission in the contract documents as follows:

Please find attached Fletcher Insulation Silencer Batts technical data sheet for our alternative to the bulk thermal insulation specified on page 130 item 4.1. Note the proposed product has a R1.9. Sample is on site for viewing if required.

We request that you provide your written instruction on how you wish to resolve this discrepany/ommission.

Issued by: Grace Wuth

Subcontractor: **Ref #**

APPENDIX E – RFI REGISTER EXAMPLE

The following is just a snapshot of a typical RFI register for the tracking of RFIs on a project.

mcnab
relationship builders

RFI REGISTER

Date of Issue:	22-October-2013

Project:	Masonic Care Queensland - Townsville	Job # 10072

RFI #	Date Sent	Title	Response Req'd By	Final Response Recieved	Comments
201	13/10/11	East Apartments - Roof Trusses Shop Drawings Review	14/10/11	14/10/2011	
202	14/10/11	East Apartments Plantation Shutter to WIR	18/10/11	18/10/2011	
203	14/10/11	Navlam to East Apartments Entry Doors	18/10/11	14/10/2011	
204	17/10/11	New Location for Pit 1/18	20/10/11	10/11/2011	
205	18/10/11	Artwork Proof - Project Signboard	18/10/11	18/10/2011	
206	18/10/11	RACF Bed Heads - Fixing Method	20/10/11	1/11/2011	
207	18/10/11	Ceiling height amendments to accomodate mechanical ductwork	20/10/11	24/10/2011	
208	18/10/11	Community Building Fire Sprinklers Shop Drawings	21/10/11	11/11/2011	
209	18/10/11	East Apartments - Type C, Bedroom 2 Robe Width	20/10/11	18/10/2011	
210	18/10/11	East apartments - basement light tech data (alternative)	21/10/11	19/10/2011	
211	18/10/11	RACF & EA - Emergency exit light tech data	21/10/11	20/10/2011	
212	19/10/11	RACF Ensuites - Location of TMV Box	21/10/11	24/10/2011	
213	19/10/11	East Apartments - Roof Over Fire Rated Wall Detail	21/10/11	19/10/2011	
214	19/10/11	RACF - Roof insulation alternate	20/10/11	21/10/2011	
215	19/10/11	Electrical Shop Drawings - Typical Bedrooms type 1 & 2	21/10/11	24/10/2011	
216	20/10/11	RACF - Head height to window 2.01.A	21/10/11	20/10/2011	
217	20/10/11	RACF Window Reed Switches	21/10/11	2/11/2011	
218	21/10/11	Electrical Shop Drawings - RACF Bedroom Ceiling Layout	25/10/11	15/02/2012	
219	21/10/11	Mounting of Nurse Call and Access Control Equipment in Comms Racks	26/10/11	24/10/2011	
220	21/10/11	Ground Floor and Community - Nurse Call Shop Drawings for Approval	26/10/11	10/11/2011	
221	21/10/11	Ceiling Hoist Track Setout - Assisted Bath and Therapy	25/10/11	10/11/2011	
222	21/10/11	RACF - Mirrors & Recessed Mirror Cabinet In Ensuites	24/10/11	31/10/2011	

APPENDIX F – RAW DATA COLLECTION

No.	Job Number	Job Name	Contract Value ($mil)	Project Type	Project Size (m2)	Duration Expected (months)	Duration Final (months)	Duration (Averaged)	# of Dwgs	Number of RFI's
1	10051	UQ Gatton Water Storage	0.6	Civil	10000	1.25	2.3	1.8	17	4
2	00946	USQ Test Facility Shed	0.9	Education	650	3.50	3.4	3.4	10	33
3	09707	Toowoomba Sports Club	1.4	Commercial	1120	3.75	5.3	4.5	86	7
4	00918	Benowa State High School	1.4	Government	728	4.75	5.1	4.9	40	7
5	00910	Brisbane Children's Court	1.7	Government	2135	2.86	9.2	6.0	135	38
6	10071	BHP Billiton, Townville (new office)	1.8	Commercial	360	7.00	9.0	8.0	71	88
7	00936	Village on the Downs Stage 16	1.8	Residential/Retirement	1442	5.00	15.2	10.1	55	25
8	09744	St Francis AYR	1.9	Education	1060	6.00	6.1	6.1	55	11
9	09701	MYCNC Dalby	1.9	Residential/Retirement	31257	6.00	7.1	6.5	65	27
10	09793	Toowoomba Christian Indoor Sports Facility	2.1	Education	1618	4.75	7.8	6.3	43	26
11	09775	Unity College Caloundra	2.2	Education	1242	6.00	6.4	6.2	60	17
12	10170	TradeCoast Lot 154 (Sasgar)	2.3	Industrial	1694	5.00	5.0	5.0	78	41
13	09767	Affordable Housing - Beenleigh	2.9	Residential/Retirement	1519	5.00	8.2	6.6	69	47
14	09757	Affordable Housing, Townsville	3.2	Government	2023	10.00	18.3	14.2	128	84
15	13026	UQ Munro Childcare Centre	3.3	Education	1238	8.75	7.9	8.3	130	26
16	00901	Black Toyota Warwick	3.4	Commercial	2404	5.95	6.1	6.0	95	25
17	09713	UQ Gatton Pool	4	Education	3200	7.25	15.2	11.2	80	127
18	09769	Abbot Point	4.4	Commercial	800	8.25	11.2	9.7	65	94
19	09768	37 NIX & 1-3 Tuffley St	4.4	Residential/Retirement	1896	6.00	13.2	9.6	84	50
20	10042	UQ Dairy Integration, Gatton	4.6	Industrial	3100	7.50	8.0	7.8	73	64
21	11178	35ML Water Containment Pond, Fluor	4.7	Civil	40000	4.00	6.1	5.1	20	40
22	00956	St Pauls Terrace	4.7	Commercial	2240	10.25	13.9	12.1	120	45
23	10028	Energex Southern Distribution Depot, Larapinta	5.4	Industrial	1012	5.50	11.2	8.3	90	46
24	09758	Tully Multi Purpose Centre	5.7	Education	1750	7.50	15.2	11.4	202	89
25	09819	Marist College Science Centre	6	Education	3035	8.00	10.3	9.1	230	86

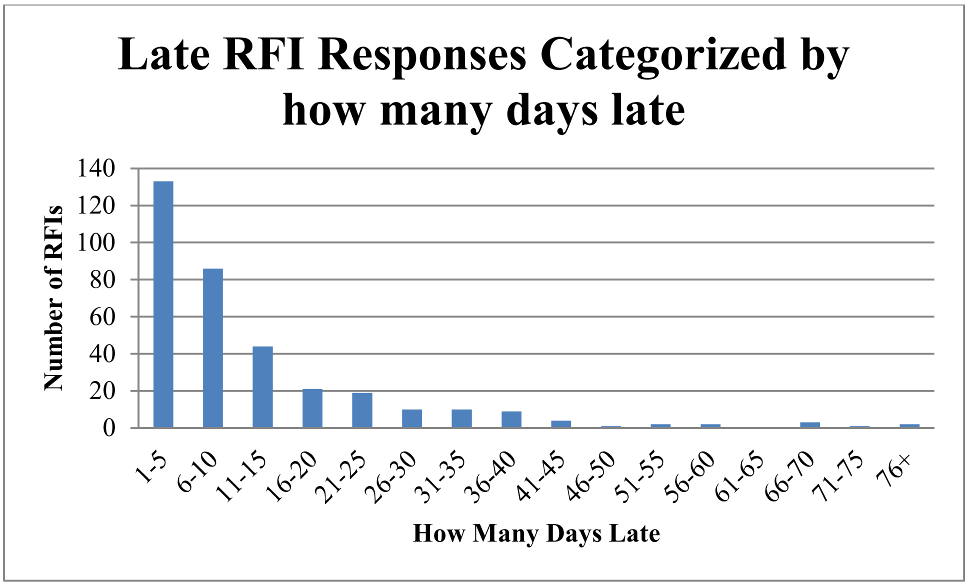
26	10180	UQ Library Warehouse	6.1	Education	3356	5.50	7.5	6.5	80	57
27	11097	Hymba Yumba	6.2	Education	3568	11.00	15.2	13.1	221	92
28	00916	Tradecoast Lot 12 (Enerflex)	6.2	Industrial	5632	7.00	5.1	6.1	165	37
29	00951	King's College	6.3	Education	4320	13.00	15.2	14.1	188	166
30	10074	Aldi Supermarket - Kelvin Grove	6.9	Commercial	2400	6.75	7.5	7.1	280	80
31	00953	St Anthony's Catholic College	6.9	Education	2283	8.00	9.1	8.6	160	104
32	09750	Rangeville Community Church	7.2	Commercial	3200	9.00	11.2	10.1	276	46
33	09702	Palm Beach Pool	7.3	Government	2000	6.50	6.0	6.3	145	95
34	00927	Townsville Bulletin	7.78	Industrial	1456	10.00	4.1	7.0	136	151
35	10099	Northlakes Integrated Facility	8.7	Commercial	5753	7.05	9.0	8.0	226	53
36	00905	Murarrie Road	8.7	Industrial	7440	7.64	5.1	6.4	125	23
37	10032	TradeCoast Lot 16 (EB Games)	10.2	Industrial	32820	8.00	8.2	8.1	115	71
38	10158	Lot 40 Tradecoast Central	10.5	Industrial	29000	7.50	8.1	7.8	111	67
39	10150	TradeCoast Lot 26 (Reece)	11.5	Industrial	26325	8.00	4.4	6.2	188	89
40	12058	QGC Concrete Works 3+1	12	Civil	6000	4.13	6.1	5.1	267	123
41	10059	TradeCoast Lot 21 (Energex)	13.4	Industrial	43900	9.50	4.9	7.2	215	81
42	00949	High Street Plaza	14.7	Commercial	12000	14.50	17.5	16.0	283	324
43	00957	BHC Church Street	15.5	Residential/Retirement	7440	13.50	14.6	14.1	344	481
44	09763	Regis Fairfield Manor Yeronga	15.9	Residential/Retirement	3500	12.00	16.3	14.1	412	119
45	11049	JCU Specialist Teaching and Student Services Precinct (STSSP)	17.8	Education	4174	13.00	14.6	13.8	180	455
46	09824	Village at Coorparoo	19.3	Residential/Retirement	10862	13.00	12.2	12.6	443	130
47	11124	The Village at Coorparoo, Stage 2	23.3	Residential/Retirement	5775	15.00	7.1	11.1	482	85
48	10072	Masonic Care, Kirwan	34	Residential/Retirement	21344	16.75	20.0	18.375	1684	687

APPENDIX G – RFI LATE RESPONSES (MASONIC CARE, KIRWAN)

This is a case study into late RFIs on the Masonic project, to demonstrate how many RFIs are responded to after their due date. These late responses are further categorized by how many days late they were to show the spread.

Total RFI's on Masonic Care Kirwan:	687
Total RFI's that were responded to late:	347
Percentage late:	50.5%

Distribution of responses categorized by how late they were in days;



APPENDIX H – RFI DISCIPLINE DATA

RFI #	RFIs - DISCIPLINE				
	BHC Church Street	Regis Fairfield Manor Yeronga	Village at Coorparoo	The Village at Coorparoo, Stg 2	Masonic Care, Kirwan
1	N/A	M	L	A	N/A
2	E	H	H	S	SURVEY
3	E	H	A	H	A
4	A	A	E	A	H
5	A	M	H	H	S
6	S	M	A	A	H
7	D	M	H	C	H
8	D	A	A	A	C
9	S	M	A	H	E
10	L	M	H	MISC	H
11	A	H	MISC	A	C
12	S	E	N/A	A	E
13	A	A	S	A	A
14	A	A	A	S	C
15	SURVEY	A	A	A	MISC
16	S	A	C	L	A
17	N/A	A	MISC	S	SURVEY
18	S	MISC	C	A	A
19	E	A	H	A	C
20	SURVEY	A	A	H	H
21	S	A	A	E	A
22	A	A	MISC	A	S
23	H	A	E	M	E
24	N/A	A	E	M	MISC
25	A	A	A	H	C
26	A	H	A	M	A
27	A	A	S	H	H
28	MISC	A	S	A	H
29	H	A	E	H	S
30	S	A	A	A	E
31	A	A	A	M	A
32	L	A	S	C	S
33	S	A	MISC	E	M
34	MISC	MISC	L	A	H
35	A	N/A	E	E	S
36	A	S	E	E	C
37	A	H	H	E	E
38	MISC	A	L	E	E
39	A	A	D	M	S
40	C	H	L	S	H
41	SURVEY	A	H	A	N/A
42	H	A	MISC	M	SURVEY
43	SURVEY	H	S	E	H
44	H	A	A	M	A
45	A	H	A	E	MISC
46	H	M	MISC	A	A
47	H	A	E	E	A
48	H	L	H	E	A
49	S	S	C	A	MISC
50	H	H	A	H	H
51	S	A	A	A	H
52	C	S	S	A	M
53	A	A	A	A	H
54	SURVEY	MISC	E	S	H
55	S	H	E	A	S
56	S	A	S	M	S
57	S	A	S	A	E
58	S	A	E	A	M
59	S	S	E	S	E
60	S	A	E	H	C
61	C	A	M	H	H
62	C	A	S	A	A
63	A	S	S	A	H
64	SURVEY	A	A	H	H
65	S	A	M	M	S
66	H	A	A	A	A
67	A	S	A	A	H
68	S	A	A	H	M
69	A	A	A	A	M
70	A	A	A	H	E
71	E	S	A	E	A
72	S	A	A	E	E
73	A	L	A	N/A	S
74	MISC	A	A	E	MISC
75	C	S	E	L	C
76	A	A	S	A	A
77	A	A	A	H	M
78	S	A	M	S	A
79	A	A	A	E	H
80	A	A	A	A	A
81	A	S	E	E	M
82	C	A	L	H	M
83	A	A	M	A	M
84	H	A	A	A	A
85	S	H	A	M	A
86	A	S	H		N/A
87	E	A	A		H
88	E	S	E		C
89	S	S	E		E
90	E	A	A		S
91	SURVEY	A	A		A

Disciplines:
A - Architechtural
E - Electrical
H - Hydraulic
S - Structural
M - Mechanical
C - Civil
MISC - (lifts, roller shutters, etc)
L - Landscaping
SURVEY - Surveying
N/A - not applicable to specific Discipline
D - Demolition

92	E	S	A	A
93	A	S	MISC	E
94	S	A	A	H
95	E	A	E	A
96	E	C	A	S
97	A	A	L	A
98	M	A	A	E
99	M	A	A	S
100	A	A	A	H
101	C	A	A	A
102	H	A	A	S
103	MISC	A	A	A
104	A	A	A	A
105	C	A	A	A
106	A	H	A	S
107	A	A	A	A
108	S	H	A	A
109	A	A	A	E
110	C	A	A	A
111	E	A	E	E
112	E	A	C	H
113	A	A	A	E
114	E	A	A	E
115	H	E	A	A
116	A	A	E	E
117	MISC	A	A	A
118	A	L	E	S
119	A	L	A	A
120	A		A	A
121	E		E	S
122	A		A	H
123	E		E	S
124	E		E	A
125	E		A	E
126	E		A	S
127	A		A	E
128	A		MISC	A
129	H		A	E
130	H		A	H
131	E			A
132	A			A
133	A			S
134	A			H
135	H			H
136	A			E
137	A			H
138	A			L
139	A			A
140	A			A
141	M			A
142	E			A
143	H			A
144	A			S
145	E			A
146	H			A
147	H			D
148	H			A
149	S			E
150	H			A
151	H			A
152	E			H
153	H			A
154	S			S
155	S			S
156	A			H
157	A			E
158	MISC			A
159	MISC			E
160	MISC			A
161	A			S
162	M			H
163	L			S
164	H			M
165	A			S
166	M			M
167	H			A
168	C			A
169	H			E
170	H			E
171	M			A
172	A			H
173	A			A
174	M			A
175	A			A
176	MISC			A
177	A			H
178	SURVEY			H
179	N/A			S
180	S			H
181	M			E
182	H			A
183	H			A
184	E			A
185	E			H
186	E			S
187	S			A
188	A			S
189	A			H
190	H			A
191	E			E
192	E			A
193	E			A
194	H			A
195	H			MISC
196	A			A
197	M			A

198	M	H
199	E	A
200	H	S
201	C	A
202	A	A
203	S	A
204	C	E
205	H	A
206	E	A
207	H	A
208	S	H
209	H	E
210	MISC	E
211	S	E
212	H	A
213	E	A
214	E	A
215	A	A
216	MISC	A
217	S	A
218	S	E
219	S	E
220	S	A
221	H	A
222	E	A
223	A	A
224	A	M
225	SURVEY	H
226	H	A
227	E	S
228	H	S
229	H	A
230	H	A
231	SURVEY	A
232	A	A
233	SURVEY	A
234	S	A
235	A	MISC
236	H	H
237	H	M
238	H	E
239	E	A
240	A	E
241	S	H
242	S	H
243	A	A
244	E	A
245	A	S
246	H	L
247	H	E
248	S	E
249	E	C
250	A	A
251	E	A
252	H	E
253	L	A
254	E	S
255	H	A
256	MISC	A
257	E	A
258	H	A
259	H	E
260	S	S
261	H	A
262	A	A
263	E	A
264	H	S
265	H	S
266	E	H
267	A	H
268	E	MISC
269	E	S
270	A	E
271	A	M
272	A	S
273	S	A
274	E	A
275	H	S
276	A	A
277	A	E
278	S	A
279	H	H
280	H	A
281	A	E
282	A	A
283	A	E
284	S	E
285	E	A
286	E	A
287	E	A
288	SURVEY	H
289	H	E
290	A	E
291	A	S
292	H	E
293	H	A
294	E	A
295	E	A
296	A	A
297	A	A
298	A	A
299	H	S
300	S	E
301	A	A
302	H	A
303	E	A

304	H			A
305	A			A
306	A			A
307	L			H
308	E			A
309	S			A
310	S			E
311	S			A
312	E			A
313	S			A
314	S			A
315	A			A
316	A			H
317	A			A
318	A			A
319	H			M
320	A			E
321	MISC			A
322	H			M
323	S			E
324	A			M
325	S			A
326	A			A
327	S			E
328	S			A
329	S			A
330	S			A
331	A			A
332	H			E
333	S			A
334	S			S
335	S			A
336	A			E
337	A			E
338	A			S
339	A			E
340	A			A
341	A			H
342	M			H
343	A			A
344	A			H
345	S			H
346	M			E
347	E			A
348	E			A
349	A			A
350	A			A
351	A			A
352	M			A
353	A			A
354	H			H
355	A			MISC
356	A			E
357	S			A
358	E			A
359	A			A
360	E			A
361	A			A
362	H			A
363	M			A
364	A			A
365	E			M
366	S			A
367	E			S
368	H			E
369	A			A
370	S			A
371	A			A
372	A			A
373	A			A
374	A			E
375	E			A
376	A			A
377	A			H
378	H			S
379	M			A
380	A			A
381	A			S
382	A			E
383	M			A
384	E			H
385	E			E
386	A			E
387	A			A
388	A			A
389	A			A
390	A			E
391	A			A
392	A			H
393	A			L
394	A			E
395	H			N/A
396	A			L
397	H			A
398	A			A
399	A			A
400	E			E
401	A			A
402	A			A
403	A			M
404	A			M
405	A			A
406	L			A
407	H			A
408	H			A
409	A			C

410	A				A
411	A				A
412	A				A
413	H				A
414	A				H
415	A				A
416	A				A
417	E				A
418	A				C
419	A				A
420	L				A
421	A				A
422	A				A
423	A				E
424	A				A
425	A				H
426	A				A
427	H				A
428	A				S
429	A				A
430	H				A
431	H				A
432	E				A
433	A				E
434	A				A
435	S				M
436	A				A
437	A				A
438	A				A
439	A				A
440	A				A
441	A				A
442	H				A
443	A				E
444	A				H
445	A				A
446	A				A
447	A				H
448	A				E
449	A				E
450	H				A
451	A				A
452	A				A
453	A				A
454	E				A
455	A				H
456	A				A
457	A				A
458	A				A
459	A				E
460	A				A
461	A				A
462	H				A
463	H				A
464	A				A
465	E				E
466	E				L
467	H				S
468	E				A
469	A				E
470	A				A
471	A				H
472	L				E
473	H				S
474	A				H
475	E				A
476	E				A
477	E				A
478	L				A
479	E				MISC
480	A				M
481	E				A
482					L
483					A
484					A
485					A
486					A
487					A
488					E
489					A
490					A
491					H
492					A
493					H
494					E
495					A
496					H
497					E
498					H
499					A
500					H
501					E
502					C
503					A
504					S
505					A
506					A
507					A
508					A
509					E
510					E
511					A
512					A
513					A
514					A
515					L

516					M
517					E
518					A
519					A
520					A
521					E
522					A
523					A
524					M
525					A
526					A
527					A
528					E
529					A
530					A
531					A
532					A
533					A
534					E
535					A
536					A
537					MISC
538					A
539					E
540					A
541					A
542					A
543					A
544					L
545					A
546					A
547					A
548					E
549					E
550					A
551					E
552					E
553					A
554					E
555					M
556					A
557					A
558					E
559					A
560					A
561					A
562					E
563					A
564					S
565					A
566					E
567					S
568					E
569					A
570					A
571					A
572					E
573					A
574					A
575					A
576					E
577					H
578					A
579					A
580					E
581					A
582					H
583					H
584					E
585					H
586					H
587					A
588					A
589					A
590					A
591					A
592					A
593					A
594					A
595					C
596					A
597					E
598					A
599					L
600					A
601					A
602					A
603					H
604					A
605					A
606					A
607					N/A
608					E
609					H
610					A
611					A
612					SURVEY
613					E
614					H
615					E
616					A
617					A
618					H
619					L
620					E
621					S

622					E
623					E
624					E
625					H
626					H
627					A
628					A
629					A
630					L
631					E
632					E
633					H
634					A
635					A
636					S
637					A
638					E
639					E
640					A
641					H
642					L
643					A
644					E
645					H
646					E
647					H
648					A
649					L
650					E
651					A
652					E
653					C
654					E
655					H
656					A
657					H
658					H
659					E
660					L
661					SURVEY
662					A
663					N/A
664					A
665					E
666					C
667					A
668					A
669					E
670					C
671					C
672					S
673					A
674					L
675					A
676					H
677					N/A
678					A
679					A
680					A
681					E
682					C
683					L
684					A
685					A
686					A
687					S